FORM F. R. 50

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

SPECIFICATIONS

FOR

FOREST ROAD CONSTRUCTION

REVISED 1927

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON
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DEFINITION OF TERMS

Whenever in these specifications, bid, contract, and bonds, the following terms, or pronouns in place of them, are used, the intent and meaning shall be interpreted as follows:

Secretary.—The Secretary of Agriculture of the United States.

Contracting officer.—The officer signing the contract upon behalf of the United States of America.

Chief of Bureau.—Chief of Bureau of Public Roads, United States Department of Agriculture, who hereby is designated an authorized representative of the contracting officer.

Chief Engineer.—Chief engineer of the Bureau of Public Roads, United States Department of Agriculture, who hereby is designated an authorized representative of the contracting officer.

Engineer.—The district engineer of the United States Bureau of Public Roads, in whose district the proposed improvement is to be located, who hereby is designated an authorized representative of the contracting officer.

Inspector.—An authorized representative of the engineer, assigned to make any or all necessary inspections of the work performed and materials furnished by the contractor.

Bidder.—Any individual, firm, or corporation submitting a bid for the work contemplated, acting directly or through a duly authorized representative.

Contractor.—Party of the second part to the contract, acting directly or through a lawful agent or employee.

Surety.—The surety which is bound with and for the contractor, who is primarily liable, and which engages to be responsible for the payment of all debts pertaining to, and for the acceptable performance of the work contracted for.

Bid.—The approved prepared form on which the bidder is to submit or has submitted a bid for the work contemplated.

Bid guaranty.—The security designated in the bid, to be furnished by the bidder receiving the award of the work, as a guaranty of good faith to enter into a contract with the party of the first part.

Plans.—The official approved plans, profiles, typical cross section, general cross sections, working drawings and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions, and details of the work to be done, and which are to be considered as a part of the contract supplementary to these specifications.

Specifications.—The directions, provisions, and requirements contained herein as supplemented by such special provisions and supplemental agreements as may be necessary, pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the contract. Special provisions are intended to cover work appertaining to a particular project and proposed in the estimate, but not satisfactorily covered by these general specifications. Special provisions will govern the work and take precedence over the general specifications wherever in conflict therewith. Supplemental agreements are written agreements executed by the contractor with the assent of the surety and the contracting officer modifying the contract to cover changes or changed conditions incidental and necessary to the project.

Contract.—The agreement between the United States of America by the contracting officer and the contractor covering the performance of the work and the furnishing of materials in the construction thereof. The contract shall include invitation for bids, instructions to bidders, bid, bid guaranty, the plans, specifications, special provisions, and performance bond, also any and all supplemental agreements which are required to complete the construction of the roadway in a substantial manner.

Performance bond.—The approved form of security furnished by the contractor and his surety as a guaranty of good faith on the part of the contractor to execute the work in accordance with the terms of the contract.

Highway.—The whole right of way which is reserved for and secured for use in constructing the roadway and its appurtenances.

Roadway.—That portion of the highway included between the outside lines of gutters or side ditches, including also the appertaining structures, and all slopes, ditches, channels, waterways, etc., necessary to proper drainage.

Roadbed.—That portion of the roadway between the inside edges of slopes of ditches and tops of fill slopes; the subgrade plus the shoulders.

Subgrade.—That portion of the roadbed upon which the surfacing material is to be placed.

Culverts.—All waterway structures not defined as bridges.

Bridges.—Structures of over 20-foot span measured under the copings, along the center line of the road, and multiple span structures where the individual spans are in excess of 10 feet. The width of bridges is the distance between inside faces of curb.

The work.—All the work specified or mentioned herein or indicated on the plans.

Bridge complete.—The entire structure, including both substructure and superstructure.

Substructure.—All of that part of the structure below the bridge seats or below the spring lines of arches. Parapets, backwalls, and wingwalls of abutments shall be considered as parts of the substructure.

Superstructure.—All of that part of the structure above the bridge seats or above the spring lines of arches.

Laboratory.—The laboratories of the Bureau of Public Roads or other laboratories designated by the chief engineer.

SCOPE OF WORK

Intent of plans and specifications.—The intent is to prescribe a complete work or improvement which the contractor undertakes to do, in full compliance with the plans, these specifications, the special provisions, proposal, and contract. The contractor shall perform all earthwork, construct all surface courses, build all structures and incidental construction, and perform extra work, all in accordance with the lines, grades, typical cross section, and dimensions shown on the plans, and shall furnish, unless otherwise provided in the special provisions or in the contract, all materials, implements, machinery, equipment, tools, supplies, and labor necessary to the prosecution of the work.

Special work.—Proposed construction or requirements not covered by these specifications will be covered by special provisions and performed or complied with by the contractor.

Increased or decreased quantities.—The right is reserved for the contracting officer to make such alterations in the plans or in the quantity of the work as may be considered necessary or desirable during the progress of the work to complete fully and perfectly the proposed construction, provided such alterations do not change materially the original plans and specifications. Such alterations shall not be considered as a waiver of any conditions of the contract nor invalidate any of the provisions thereof. The contractor shall perform the work as increased or decreased at the unit price stated in the bid and no allowance will be made for anticipated profits.

The Secretary has programmed for the work on this project a certain sum as stated in the special provisions. In case the contract awarded for this work shall leave available any portion of the funds so programmed, the right is reserved to extend this contract to such extent as will absorb the funds so remaining available, either by increasing quantities of work to be performed or by increasing the length of the project beyond the termini as shown on the plans; provided, that no such extension shall be made which will exceed in amount 25 per cent of the original amount of this contract. The right is also reserved to shorten the project if necessary to keep the cost of the work within the above funds.

Extra work.—Unforeseen work made necessary by minor alteration of plans, or by other reason, or work necessary to complete the proposed improvement, for which no price or compensation is provided in the contract, shall be deemed extra work and shall be performed by the contractor in accordance with the specifications and as directed; provided, however, that before any extra work is started a written order from the engineer shall be delivered to the contractor to do the work, the order stipulating that the work shall be paid for at the stated unit price or lump sum agreed upon previously by the contractor and engineer; or failing such agreement the order shall stipulate that the work shall be done on a force account basis.

Maintenance of detours.—There shall be provided and maintained in passable condition such detours, temporary highways and bridges as may be necessary to accommodate the general public, residents adjacent to the improvement, and the United States mails. Temporary approaches and crossings of intersecting highways shall be provided and maintained in a safe condition. Detours adjacent to or contiguous to the work shall be constructed and maintained by the contractor and no allowance will be made therefor; provided, however, that for such purpose the contractor will not be required to construct or maintain structures of over 20-foot span. Detours which are not adjacent to or contiguous to the work will not be at the charge of the contractor.

Removal and disposal of structures and obstructions.—All fences, buildings, structures of any character not necessary to the construction of the roadway, or other encumbrances upon or within the limits of the right of way, shall be removed by the contractor and carefully placed on the abutting property or otherwise disposed of, if and as required.

Rights in and use of materials found on the work.—The contractor, with the approval of the engineer, may use in the proposed construction suitable stone, gravel, or sand found in the excavation and will be paid for the excavation of such materials at the corresponding contract unit price therefor, but he shall replace at his own expense with other suitable material all of that portion of the material so removed and used as was contemplated for use in the embankments, back-fills, approaches, or otherwise. No charge for materials so used will be made against the contractor except the replacement herein provided for. The contractor shall not excavate or remove any material from within the highway location which is not within the excavation, as indicated by the slope and grade lines, without written authorization from the engineer.

Final cleaning up.—Before acceptance and final payment shall be made when the work is completed, the right of way, borrow pits, and all ground occupied by the contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, and equipment, and all parts of the work shall be left in a neat and presentable condition.

CONTROL OF THE WORK

Plans.—The approved plans shall be supplemented by such working drawings as are necessary to adequately control the work. It is mutually agreed that all authorized alterations affecting the requirements and information given on the approved plans shall be in writing.

Working drawings for any structure shall consist of such detailed plans as may be required for the prosecution of the work and are not included in the plans furnished by the engineer. They shall include shop details, erection plans, masonry layout diagrams, and bending diagrams

for reinforcing steel, approval of which by the engineer must be obtained before any work involving these plans shall be performed. Plans for cribs, cofferdams, false work, centering, and form work may also be required and in such case shall be likewise subject to approval by the engineer.

The contract price shall include the cost of furnishing all working drawings.

Conformity with plans and allowable deviations.—Finished surfaces in all cases shall conform with lines, grades, cross sections, and dimensions shown on the approved plans. The crown, or rise, of the finished surface of the roadway from the curb or side line to the center line shall be as shown on the typical cross section of the plans, except at intersecting highways or wherever, to insure correct drainage or for other reasons, changes may be directed. On curves or at other places, where deemed necessary, the contractor may be required to superelevate the roadway. Such other deviations from the plans, approved working drawings, and specifications as may be required by the exigencies of construction will in all cases be determined by the engineer and authorized in writing.

Coordination of plans, specifications, and special provisions.—These specifications, the accompanying plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be mutually supplementary and, to describe and provide for a complete work. In case of discrepancy, figure dimensions shall govern over scaled dimensions, plans shall govern over specifications, special provisions shall govern over both specifications and plans. In case of conflict between the plans, specifications, or special provisions and the "Standard Government Form of Invitation for Bids" (Standard Form No. 20), the Standard Government Form of Bid (Standard Form No. 21), and the Standard Government Form of Contract (Standard Form No. 23), the provisions of said standard forms shall govern.

Construction stakes.—The engineer will furnish and set construction stakes establishing lines, slopes, and continuous profile grade in road work, and center line and bench marks for bridge work, and will furnish the contractor with all necessary information relating to lines, slopes, and grades. The contractor shall furnish, free of charge, all additional stakes, all templates, and other materials necessary for marking and maintaining points and lines given, and shall furnish the engineer such labor as he may require in establishing points and lines necessary to the prosecution of the work. The contractor shall be held responsible for the preservation of all stakes and marks, and if, in the opinion of the engineer, any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them shall be charged against, and shall be deducted from, the payment for the work.

Final inspection.—Whenever the work provided and contemplated by the contract shall have been satisfactorily completed and the final cleaning up performed, the engineer shall, within 10 days, unless otherwise provided, make the final inspection.

CONTROL OF MATERIAL

Samples and tests.—Tests of all materials specified will be made by the engineer in accordance with the official approved methods described in United States Department of Agriculture Bulletin No. 1216. When tests are made at places other than the laboratory, the contractor shall furnish every facility for the verification of all scales, measures, and other devices which he operates.

Storage of materials.—Materials shall be stored so as to insure the preservation of their quality and fitness for the work.

Defective materials.—All materials not conforming to the requirements of these specifications shall be considered as defective and all such materials, whether in place or not, shall be rejected and shall be removed immediately from the site of the work, unless otherwise permitted by the engineer. No rejected material, the defects of which have been subsequently

corrected, shall be used until approval has been given. Upon failure on the part of the contractor to comply forthwith with any order of the engineer made under the provisions of this article, the engineer shall have authority to remove and replace defective material and to deduct the cost of removal and replacement from any moneys due or to become due the contractor.

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Laws to be observed.—The contractor is assumed to be familiar with, and at all times shall observe and comply with, all Federal and State laws, and local by-laws, ordinances, and regulations in any manner affecting the conduct of the work, and shall indemnify and save harmless the Government and its representatives against any claim arising from the violation of any such law, by-law, ordinance, or regulation, whether by the contractor himself or by the contractor's employees.

Restoration of surfaces opened by permit.—Upon the presentation of a duly authorized and satisfactory permit which provides that all necessary repair work will be paid for by the party to whom such permit is issued the engineer may authorize the contractor to allow parties bearing such permits to make openings in the highway.

Sanitary provisions.—The contractor shall provide and maintain in a neat, sanitary condition such accommodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State department of health or of other authorities having jurisdiction, and shall commit no public nuisance.

Public convenience and safety.—If the contractor constructs temporary bridges or provides temporary stream crossings, his responsibility for accidents shall include the roadway approaches as well as the structures of such crossings. Materials stored upon the highway shall be placed so as to cause as little obstruction to the traveling public as is considered necessary. No road shall be closed by the contractor to the public except by express permission of the engineer.

Barricades, danger, warning, and detour signs.—The contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals and signs, provide a sufficient number of watchmen, and take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. All barricades and obstructions shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise.

Use of explosives.—When the use of explosives is necessary for the prosecution of the work, the contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, in compliance with local laws and ordinances, and all such storage places shall be marked clearly "DANGEROUS—EXPLOSIVES."

Preservation and restoration of property, trees, monuments, etc.—The contractor shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the roadway; shall use every precaution necessary to prevent damage or injury thereto; shall use suitable precaution necessary to prevent damage to pipes, conduits, and other underground structures; and shall protect carefully from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location and shall not remove them until directed. The contractor shall not injure or destroy trees or shrubs nor remove or cut them without proper authority. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the nonexecution thereof on the part of the contractor, such property shall be restored by the contractor and at the contractor's expense to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring same or he shall make good such damage or injury in an acceptable manner.

Responsibility for damage claims, etc.—The contractor shall save harmless the Government and all of its representatives from all suits, actions, or claims of any character brought on account of any injuries or damages sustained by any person or property in consequence of any neglect in safeguarding the work or through the use of unacceptable materials in the construction of the improvement or on account of any act or omission, by the said contractor, or from any claims or amounts arising or recovered under the Workmen's Compensation Laws, or any other law, by-law, ordinance, order, or decree. The contractor shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct, in the manner or method of executing said work satisfactorily, or due to the nonexecution of said work or at any time due to defective work or materials and said responsibility shall continue until the roadway shall have been completed and accepted.

Contractor's responsibility for work.—Until the acceptance of the work by the engineer as evidenced in writing, the contractor shall have the charge and care thereof and shall take every necessary precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before its completion and acceptance and shall bear the expense thereof, except damages to the work resulting from slides found by the engineer to have been unavoidable and ordinary wear and tear on any section of the road open to traffic by order of the engineer. In case of suspension of work from any cause whatever, the contractor shall be responsible for all materials and shall properly store them, if necessary, and shall provide suitable drainage of the roadway and erect temporary structures, where necessary.

PROSECUTION AND PROGRESS

Subletting or assigning of contract.—The work awarded shall be performed by the contractor to whom the award is made, with the assistance of workmen under immediate superintendence, and the contract shall not be sublet, assigned, or otherwise disposed of, either in whole or in part, except with the written consent of the contracting officer.

Prosecution of work.—The contractor shall begin the work to be performed under the contract on such date as will permit its completion within the time agreed upon. The contractor shall notify the engineer at least twenty-four (24) hours before beginning work; shall start the work at the part of the road designated by the engineer; and shall prosecute the work at as many different points as the engineer shall direct.

Limitations of operations.—The contractor shall at all times conduct the work in such manner as will insure the least practicable interference with traffic and shall have due regard to convenient detours. No section of road shall be closed to the public except after permission has been granted by the engineer.

Forest fires.—The contractor will take all necessary steps to prevent the employees from setting fires not required in the construction of the project and will, under the direction of the forest officer, or in the absence of any forest officer, acting independently, extinguish such fires without expense to the United States except the cost of the forest officer's salary. Before setting any fires whatsoever the contractor will communicate with a responsible United States Forest Service officer. The contractor will abide by such rules and instructions as the Forest Service may formally prescribe as to the time and place for burning and for fire control generally. It shall be the responsibility of the contractor to prevent the escape of fires set in the construction of the project and to extinguish such as may escape without expense to the United States. The contractor's employees, when requested by a United States forest officer, shall be placed temporarily at the disposal of the United States Forest Service for the purpose of fighting forest fires in the vicinity of the right of way which are not caused by them or their employees,

with the understanding, however, that payment to such employees for such services will be made by the United States at not less than the current rate established in the said national forest for such services, and any employees furnished will be relieved from fire fighting as soon as it is practicable for the forest officer to employ other labor adequate for the protection of the national forest. If a forest officer is on the ground, the fighting of the fire will be under such officer's direction, and his salary will not be included as an item of cost.

During the period from April 1 to November 15 of each year, spark arresters satisfactory to the forest supervisor of the national forest concerned shall be maintained on all steam machinery using other than oil or gasoline for fuel.

Where the forest supervisor of the national forest concerned determines that because of high fire danger it is dangerous to burn brush unless there is present a suitable pump and water, the contractor will be required to suspend burning operations or to furnish a portable gasoline-driven pump having at least two cylinders and capable of developing a working pressure of 160 pounds per square inch and of delivering 40 gallons per minute and not less than 400 feet of 1½-inch hoze and nozzle. Such pump, with water, shall be used to extinguish all embers in the brush pile before they are left unattended.

Equipment.—The contractor shall furnish necessary and adequate equipment for the prosecution of the work in an acceptable manner and at a satisfactory rate of progress. Equipment used on any portion of the work shall be such that no injury to the roadway, adjacent property, or other highways will result from its use.

Use of Government equipment.—Available road-building equipment belonging to the Government may be used by the contractor in the performance of this contract, on condition that the contractor shall maintain all such equipment so used, shall bear the expense of such maintenance, and shall return the same to the Government in as good condition as when issued, reasonable wear and tear excepted, and on the further condition that, for the use of such equipment, the contractor shall pay a rental as provided in the special provisions or agreed upon in supplemental agreements, and that the total amount of such rental each month shall be deducted from the amount due the contractor for such month under this contract, subject to further condition that all charges for freight, demurrage, loading, and unloading, and other expenses incident to the transfer of the equipment so used from the storage warehouse of the United States Bureau of Public Roads, and either for its return thereto or for its transfer to such point not more distant as may be designated by the engineer, shall be paid by the contractor, and, further, that in the operation of such equipment the contractor will employ only operators whose qualifications have been approved by the engineer. No rental will accrue for equipment placed in storage by the contractor with the approval of the engineer, provided the methods of storing same meet the approval of the engineer. A list of available Government equipment appears under Special Provisions.

Use of Government explosives.—When explosives are furnished by the Government all expenses for demurrage, storage, handling, and hauling the explosives from the railroad siding or dock, as the case may be, to the project shall be borne by the contractor. Said explosives are to be received by the contractor and handled at his own risk subject to local laws and ordinances. The contractor shall prepare a schedule of his explosive requirements, in carload lots, which schedule shall allow at least 30 days' time for shipment of explosives by the Government. Shipments will be made in such quantities as the contractor may require for the efficient and economical conduct of the work. As payments become due the contractor under the terms of this contract, deductions shall be made for explosives furnished by the Government and used on the work. Upon the completion of the contract any surplus explosives remaining shall be returned to the Government at a point of storage on the project or to the railroad siding or dock specified, packed for shipment, as the engineer may direct. Any explosives lost or stolen while in charge of the contractor will be charged to the contractor and deductions therefor made from payments due the contractor.

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The special provisions will so state whenever Government explosives are required to be used and specify the price per pound at which Government explosives will be furnished.

Temporary suspension of work.—The contracting officer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the contractor to carry out orders given, or to perform any provision of the contract. The contractor shall immediately respect the written order of the contracting officer to suspend the work wholly or in part.

The work shall be resumed when conditions are favorable and methods are corrected, as approved in writing by the contracting officer.

The contractor shall not suspend the work without authority.

Failure to complete the work on time.—If any work shall remain uncompleted after elapse of the time specified in the invitation for bids as adjusted by the contracting officer for the completion of the work provided for in the contract, there shall be deducted from the moneys due the contractor, not as a penalty, but as liquidated damages, the amount stated in the special provisions for each calendar day of delay until the work is completed or accepted.

Termination of contractor's responsibility.—This contract will be considered complete when all work has been completed, the final inspection made, the work accepted by the engineer, and the final estimate paid. The contractor will then be released from further obligation except upon proof of error and as set forth in the performance bond.

MEASUREMENT AND PAYMENT

Measurement of quantities.—All work completed under the contract shall be measured by the engineer according to United States standard measures, unless otherwise agreed upon in writing. All longitudinal measurements for area of pavement will be made along the actual surface of the roadway and not horizontally, and no deduction will be made for fixtures in the roadway having an area of 9 square feet or less.

Scope of payments.—The contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor, tools, and equipment necessary to the completed work and for performing all work contemplated and embraced under the contract; also for all loss or damage arising from the nature of the work, or from the action of the elements, or from any unforseen difficulties which may be encountered during the prosecution of the work until its final acceptance by the engineer, and for all risks of every description connected with the prosecution of the work; also for all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified. The payment of any current or final estimate or of any retained percentage shall in no way affect the obligation of the contractor to repair or renew any defective parts of the construction or to replace any defective materials used in the construction and to be responsible for all damage due to such defects, if such defects or damages are discovered on or before the final inspection and acceptance of the work.

Extra and force-account work.—Extra work shall be performed under written orders either at prices agreed to in writing or on a force-account basis, as follows:

(*a*) For all labor, teams, and foreman in direct charge of the specific operation the contractor shall receive the current local rate of wage and the cost of the employers' liability insurance, to be agreed upon in writing before starting the work, to which shall be added an amount equal to 15 per cent of the sum thereof. No allowance shall be made for general superintendence and the use of small tools and ordinary equipment.

(*b*) For all materials used the contractor shall receive the actual cost of such materials, including transportation charges, as shown by original receipted bills, to which cost shall be added a sum equal to 15 per cent thereof.

(c) For any machine-power tools or special equipment, including pertinent fuel and lubricants, which it may be deemed necessary or desirable to use, the contracting officer shall allow the contractor a reasonable rental price to be agreed upon in writing before such work is begun for the time that such tools or equipment are in use on the work and to which sum no percentage shall be added.

The compensation as herein provided shall be received by the contractor as payment for extra work done on a force-account basis. The contractor shall make no claim for force-account work, unless performed on written order and in accordance therewith. The contractor's representative and the inspector shall compare records of extra work done on a force-account basis at the end of each day. Copies of these records shall be made upon sutiable forms provided for this purpose, and signed by both the inspector and the contractor's representative, one copy being forwarded to the engineer and one to the contractor. All claims for extra work done on a force-account basis shall be submitted to the engineer by the contractor upon certified statements, and such statements shall be filed not later than the 10th day of the month following that in which the work was actually performed.

Omitted items.—Should any items contained in the proposal be found unnecessary for the proper completion of the work contracted, the contracting officer may, upon written order to the contractor, eliminate such items from the contract and such action shall in no way invalidate the contract, and no allowance will be made for items so eliminated in making final payment to the contractor.

CONSTRUCTION DETAILS

EARTHWORK

Description.—Earthwork shall consist of clearing and grubbing, roadway and drainage excavation, excavation for structures, embankment, disposal of surplus material, borrow, overhaul, completion of subgrade and shoulders, subbase, finishing earth-graded roads, and fine grading subgrade and shoulders, all of which shall be done and paid for in accordance with these specifications.

CLEARING AND GRUBBING

Description.—Clearing and grubbing shall consist of clearing the ground of all trees, brush, rubbish, and other objectionable materials within the limits designated by the engineer, and of grubbing the roadway, including borrow pits, within the limits for grubbing as designated by the engineer.

The right of way must be cleared on each side of the center line of the road to the full width indicated on the plans, or to greater width if necessary on account of curves or long slopes as directed by the engineer. All trees, brush, and other vegetable matter within the space designated shall be cut down, and all tree branches extending into the right of way which hang within 20 feet of the ground shall be cut off close to the bole in a workmanlike manner. All stumps and all trees, the stumps of which are not to be grubbed, shall be cut not more than the diameter of the stump and in any instance not more than 2 feet above the ground.

From the space required for the roadbed and necessary slopes and side drains, except where embankments at the point in question are 3 feet or more in height, all stumps, large roots, and other embedded wood or vegetable matter, including duff, shall be grubbed or blasted from the ground and removed.

The contractor may secure from the forest supervisor, under free administrative use permit, timber cut from the right of way, when through Government land, for drainage or other structures and for camp use. In the event that timber for these purposes is not available on

the right of way the contractor may secure the necessary timber, if available, under free administrative use permit from such national forest area or areas as the forest supervisor shall designate. Conditions covering the cutting and removal of timber and the disposal of brush and refuse will be contained in each administrative use permit.

All timber shall be felled in the right of way, and all trees, together with all brush, stumps, roots, duff, and other débris, must be placed in piles, in such a manner as to be completely consumed when the pile is burned. In case the burning is to precede the construction operations the piles may be placed in the center of the right of way; otherwise the piles should be placed in the most convenient place to the side of the right of way and beyond fill slopes, where they may be burned without damage to the surrounding forest cover. In no case will it be permissible merely to throw the refuse outside of the right of way or to place it in windrows at the side of the right of way. The material placed in piles shall be burned by the contractor unless otherwise specified, at such time and in such manner as absolutely to prevent the fire from spreading to areas adjoining the right of way.

When the forest supervisor of the national forest concerned determines that the proper protection of the national forest from fire demands that burning operations shall be discontinued, the contractor shall make such temporary disposal of the material on the ground as the engineer may indicate.

Trees of value to the appearance of the road and not coming within the slopes shall be left upon order of the engineer, but all underbrush and débris shall be cleared out from around them. Payment for such work shall be the same as for other clearing above specified.

Method of measurement.—The area to be measured in payment for this item shall be that included within the limits as designated for clearing and as designated for grubbing.

Basis of payment.—Clearing and grubbing will be paid for at the prices per acre bid for clearing and for grubbing, respectively, which prices will include all equipment, tools, labor, and incidentals necessary to complete the work.

ROADWAY AND DRAINAGE EXCAVATION

Description.—This work shall consist of excavating the roadway, the removal and satisfactory disposal of all materials taken from within the limits of the work, and shall include all excavation, shaping, and sloping necessary for the construction and preparation of the embankments, subgrade, shoulders, slopes, all gutters, ditches, intersections, approaches, and private entrances, as directed, to the required alignment, grade, and cross section shown on the plans.

All material excavated shall be unclassified and paid for as such, unless proposal prices are asked and bid for solid rock excavation and common excavation.

Common excavation.—Common excavation shall include the removal of all decomposed rock, shale, hardpan, earth, muck, clays, loam, sand, gravel, soft sandstone, soapstone, all loose stone bowlders individually measuring less than one-half cubic yard in volume, and all material which is not included in the specifications for solid rock excavation.

Solid rock excavation.—Solid rock excavation shall include the removal of all bowlders one-half cubic yard in volume or greater and all hard rock found in place which, in the opinion of the engineer, can only be removed by blasting.

Excavated rock shall be used in forming embankments wherever the depth of fill is sufficient to properly contain the rock removed by excavation, and shall be placed in accordance with directions given by the engineer. The engineer may permit the contractor to use excavated rock for purposes other than embankments, and in such case the contractor shall furnish and place, at his own expense, an amount of borrow equal to the deficiency caused by the rock being used elsewhere, if it is found necessary to borrow material to bring any part of the road to grade.

Construction methods.—All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankment, subgrade, shoulders, and at

such other places as directed. No excavated material shall be wasted without permission, and when such material is to be wasted it shall be disposed of as directed by the engineer. No payment will be made for any excavated material which is used for purposes other than those designated. During the construction of the roadway the roadbed shall be maintained in such a condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments shall be so constructed as to avoid damage to embankments by erosion.

Ditches.—Ditches shall be interpreted to mean roadway ditches, changes in channels of streams, and ditches parallel to or adjacent to roadway, but beyond the limits of the roadway section as constructed, whether the excavation is dry or wet. Inlet and outlet ditches to culverts and other structures are not included here but are included under excavation for structures. All roots, stumps, and other foreign matter in the sides and bottom of the ditch shall be cut to conform to the slope, grade, and shape of the section shown. The contractor shall maintain and keep open and free from leaves, sticks, and other débris all ditches dug by him until final acceptance of the contract.

The contractor shall dispose of the excavated material as directed by the engineer. The material excavated from all ditches and channel changes within 50 feet of the center line shall be placed in the embankments, or used for widening the same, when directed by the engineer. No excavation, or spoil, from a ditch shall be deposited or left within 3 feet of the edge of ditch, unless otherwise shown on the plans or directed by the engineer in writing.

Method of measurement.—All accepted roadway and drainage excavation shall be measured in its original position by the method of average end areas, which measurements will include overbreakage or slides in common excavation, not attributable to carelessness of the contractor, and authorized excavation of solid rock below grade, also of soft and spongy spots below grade. The measurement shall include unavoidable overbreakage in solid rock excavation to an amount not to exceed in any half station of 50 feet, 10 per cent of the actual quantity required for the same half station within the lines shown on the plans.

Basis of payment.—The yardage of roadway and drainage excavation, measured as provided above, shall be paid for at the contract unit price per cubic yard bid for unclassified excavation, common excavation, or solid rock excavation, as the case may be, which price shall be full compensation for formation and compaction of embankments, disposal of surplus materials, preparation and completion of subgrade and shoulders, and the furnishing of all equipment, tools, labor, and incidentals necessary to complete the work.

EXCAVATION FOR STRUCTURES

Description.—This work shall consist of all excavation for foundations for culverts, bridges, and all other structures, and for inlet and outlet ditches to culverts and other structures, except as hereinafter provided; this work shall include the disposal of all material obtained from such excavation and back filling to the level of the original ground. It shall also include all necessary bailing, draining, sheeting, and the construction of cribs or cofferdams if found necessary. The material shall be disposed of as directed by the engineer and in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

All material excavated shall be unclassified and paid for as unclassified excavation for structures, unless otherwise provided in special provisions.

For cribs and cofferdams, detail drawings shall be submitted to the engineer for approval. They shall be so designed and constructed that they will withstand with usual factors of safety for timber any usual or ordinary side pressures when pumped out, as well as any vertical loads, including provisions for loading boxes or platforms with loads required to insure stability.

Construction methods.—All excavation shall be carried to depth of foundation materials satisfactory to the engineer, regardless of the elevations shown on the plans, and unsuitable material shall be replaced with approved material if required. If rock bottom is secured, the

excavation shall be done in such a manner as to allow the solid rock to be exposed and prepared in horizontal beds for receiving the structure, except that for arch substructures, the bottom shall be sloped or stepped as directed by the engineer. All rock or hardpan foundation surfaces shall be freed from loose or disintegrated pieces, thin strata shall be removed, and the surfaces cut to firm bearing and cleaned to the satisfaction of the engineer.

Where concrete or masonry is to be placed on any excavated surface special care shall be taken not to disturb the bottom of the excavation more than necessary, and the final removal of the material to grade shall not be made until just before the concrete or masonry is laid. All seams or crevices shall be cleaned out and filled with concrete mortar. When the excavation is at the required depth, water if present shall be pumped out, if possible, for cleaning the foundation bed for inspection. The natural ground adjacent to the structure shall not be disturbed without permission of the engineer.

The excavation lines and bases of structures shown on the plans shall be considered as approximate only, and they may be ordered in writing by the engineer to be placed at any elevation, or of any dimensions necessary to give a satisfactory foundation, and no additional compensation will be allowed for any such change except as provided under basis of payment.

Bowlders, logs, or any unforeseen obstacles encountered in excavating shall be removed and no additional compensation will be allowed because of difficulties found in driving through or removing such obstructions.

All timber, sheeting, and other material used in making the excavation shall be removed except as ordered by the engineer, and the cost of performing this work shall be considered as covered by the bid price for excavation.

The back fill shall be made of material satisfactory to the engineer, in layers not more than 6 inches thick, and each layer shall be thoroughly tamped before placing the next succeeding layer. Fill placed around culverts and piers shall be deposited on both sides to approximately the same elevation at the same time. Especial care shall be taken to prevent any wedging action against the structure, and the slopes bounding the excavation shall be stepped or serrated to prevent such wedge action. In cases where the material used in making the back fill is difficult to compact, the engineer may require each layer to be flushed with water.

Method of measurement.—The yardage to be paid for will be the yardage, measured in original position, of the material actually removed as hereinbefore prescribed, except that no yardage will be included of excavation outside of a volume bounded by vertical surfaces, 18 inches outside the neat footings and parallel thereto. For inlet and outlet ditches the measurement will be to the depths and lines established by the engineer.

Basis of payment.—Payment for all work prescribed under this item and measured as provided above shall be made at the contract unit price bid per cubic yard for unclassified excavation for structures, which price shall be full compensation for furnishing all material, for all labor, equipment, tools, and incidentals necessary to complete the work; provided that in the case of bridges when it is found necessary to carry footings more than 3 feet below the elevation shown on the plans, such excavation shall be paid for as extra work.

EMBANKMENT

Construction methods.—Embankments shall be formed of suitable material. Where the method of construction will permit the material shall be placed in successive layers and not more than 12 inches in depth for the full width of the cross section. Where rock is being used in the embankment it shall be carefully distributed, and the interstices filled with earth to form a dense, compact mass. Written permission from the engineer must be secured before trestles may be used in the construction of embankments, and when trestles are so used and left in place they must be cut 2 feet below subgrade.

The contractor shall be responsible for the stability of all embankments made under the contract and shall bear the expense of replacing any portions which have become misplaced

due to carelessness or negligent work on the part of the contractor or to damage resulting from natural causes, such as storms, cloud-bursts, etc., not attributable, in the opinion of the engineer, to unavoidable movements of the natural ground upon which the embankment is made. Embankments over and around pipes, culverts, arches, and bridges shall be of selected materials placed and thoroughly tamped and compacted, as directed by the engineer, so as to avoid undue strain on the structure. Traffic over the work during construction shall be distributed so as to cover the entire surface.

The contractor will be required by the engineer to construct embankments so that, after shrinkage and settlement are complete, all embankments shall have the required grade and cross section at all points.

Compensation.—Embankment will not be measured or paid for directly. It shall be considered a necessary part of the work paid for as unclassified excavation, common excavation, solid rock excavation, excavation for structures, or borrow, as the case may be.

DISPOSAL OF SURPLUS MATERIAL

All surplus excavation and waste material shall be used to widen embankments uniformly or to flatten slopes, or shall be deposited in such other places and for such purposes as the engineer may direct. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the engineer. The contractor shall not borrow and waste without written application to and written consent from the engineer. Under no circumstances shall he be paid for excavation beyond the established line of the roadway prism, or for borrow, when such excavation or borrow results from the method of borrow and waste, nor for overhaul not actually required by the design. The work described under this item will not be measured or paid for direct. It shall be considered a necessary part of the work for unclassified excavation, solid rock excavation, excavation for structures, or common excavation, as the case may be.

BORROW

Description.—Borrow shall consist of excavation, and disposal as directed, of satisfactory material obtained from borrow pits designated, staked, and measured by the engineer. Borrow shall be used when sufficient quantities of suitable materials are not available from the roadway and drainage excavation to properly form the embankments, subgrade, shoulders, and to complete the back filling of structures. Where conditions are favorable, borrow pits in cuts to widen the inside of curves shall be designated by the engineer.

Construction methods.—The contractor shall notify the engineer sufficiently in advance of the opening of any borrow pit so that elevations and measurements of the existing ground surface may be taken. All borrow pits shall be neatly trimmed, and left in such shape as to admit of accurate measurement after the excavation is completed. Where practicable they shall be so excavated that no water will collect or stand therein.

Method of measurement and basis of payment.—Borrow shall be measured in its original position by the method of average end areas. The yardage so measured shall be paid for at the contract unit price per cubic yard bid for unclassified excavation, rock excavation, or common excavation, provided, however, that no payment whatever will be allowed the contractor for any material excavated from borrow pits or elsewhere prior to the staking out and cross sectioning of the work by the engineer, and rock excavation will not be allowed unless ordered in writing by the engineer.

OVERHAUL

When, in constructing embankments as directed, excavated or borrow material is hauled more than 500 feet, overhaul will be allowed on such material. The overhaul distance will be the distance between the centers of volume of the material in its original position and after

placing, less 500 feet. This distance shall be measured along the shortest practicable route. The number of station-yards of overhaul shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in feet, divided by 100.

Basis of payment.—Overhaul will be paid for at the unit price per station-yard bid for overhaul.

SUBGRADE

Description.—After the earthwork has been substantially completed and after all drains have been laid, the subgrade shall be brought to the lines, grades, and cross sections shown on the plans. Subgrade rolling will not be required unless prescribed in special provisions.

Construction methods.—All soft and unstable material and other portions of the subgrade which will not compact readily shall be removed as directed. All bowlders appearing in the earth excavation shall be removed or broken off to a depth to not less than 6 inches below the subgrade. All rock sections shall be brought to grade by depositing a satisfactory cushion material to the depth authorized by the engineer and all holes or depressions shall be filled with approved material and the subgrade brought to line and grade and compacted; this material shall be obtained as excavation or borrow and paid for as such unless otherwise directed in writing.

If the surface of an old stone or gravel roadbed conforms approximately to the surface of the finished subgrade at sections where reconstructed base course is not proposed, such sections shall be scarified superficially as directed to a uniform depth below and for the full width of the subgrade to a depth just sufficient to eliminate all depressions and to permit of uniform reshaping.

Highway intersections.—All intersecting public highways shall be graded as shown on the plans or as directed by the engineer, and acceptable materials used on the surface so that a commodious, smooth-riding, and satisfactory intersection shall be produced.

Railway intersections.—At all grade crossings of intersecting railways the contractor shall construct the roadway so that a commodious, smooth-riding, and satisfactory intersection is obtained, meeting the requirements of the railway company. Four-inch planking for the full width of the roadway shall be securely spiked to the ties between the rails and on the extension of the ties outside the rails in such manner that the surface of the planking will coincide with the grade of the tops of rails.

Protection of subgrade.—At all times ditches and drains along the subgrade shall be so maintained as to drain it effectively. When ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade, and if necessary be reshaped and rerolled. In no case shall any surface course or pavement be placed on a frozen or muddy subgrade. Storage or stock piling of materials on the subgrade will not be permitted. Until the subgrade has been checked and approved, no surface course or pavement shall be laid thereon.

Compensation.—Subgrade work shall not be measured and paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation, common excavation, rock excavation, excavation for structures, or borrow.

SHOULDERS

Description.—After the earthwork has been substantially completed, and after all drains have been laid, the shoulders shall be constructed of approved material to the elevation and shape shown on the plans, and, after surface course or pavement is completed, dressed as directed to the full width of the roadbed.

Construction methods.—Before any subgrade shall be approved the adjacent shoulders shall be constructed to the full width and at least to the level of the finished subgrade, but not necessarily to the final height and shape. In all cases where subgrade rolling is required, it shall

be extended onto the shoulders for a distance of at least 1 foot outside the pavement or surface course. At all times construction shall be so carried on that the subgrade, shoulders, and adjacent ditches will be effectively and completely drained. When the surface course or pavement is completed the shoulders shall be shaped and dressed, as directed, to the lines, elevations, and cross section shown on the plans. This work shall be done in proper sequence with the surface course or pavement construction as directed.

Basis of payment.—This work shall not be measured or paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation, rock excavation, excavation for structures, common excavation, or borrow.

SUB-BASE

Description.—This item shall consist of special approved material placed and compacted when directed by the engineer in excavations made by the removal of soft, unstable, or other unsuitable subgrade materials and shall be constructed only where specifically directed and in accordance with these specifications.

Material.—The material to be used shall consist of sound, tough, durable telford stone, knapped field or quarry stone, crushed rock, slag, or gravel, and necessary filler. The telford stone shall be approximately rectangular in section from 2 to 6 inches in width, 6 to 12 inches in length, and approximately 8 inches in depth; the field or quarry stones shall be not more than 5 inches in their largest dimension after knapping; and the crushed rock, slag, or gravel shall consist of pieces varying from 1 inch to 3½ inches in diameter. When a finer material is necessary for the filler, quarry chips, gravel, or sand may be used to an amount not over 15 per cent of the total. All material shall be approved before being used.

Construction methods.—Unsuitable subgrade materials shall be removed and the bottom of the excavation shaped uniformly and compacted firmly and provision made for drainage. The material shall then be placed in the prepared excavations. If telford stones are used, they shall be laid at right angles to the center line of the roadway and rammed in layers of not more than 8 inches in depth; or if knapped field or quarry stone, crushed rock, slag, or gravel is used, it shall be spread and rammed in layers of not more than 5 inches. After the material has been placed in layers until level with the surrounding subgrade surface the voids shall be filled with the finer material and the work rolled or tamped if inaccessible to the roller; and the filling and rolling shall be continued until the entire mass is compacted throughly and satisfactorily. The surface shall be finished to conform accurately to the grade and cross section of the surrounding subgrade.

Basis of payment.—This work will be paid for at the contract unit price per cubic yard bid for subbase complete in place, which price shall be full compensation for furnishing, hauling, and placing all materials and for all equipment, tools, labor, and incidentals necessary to complete the work.

FINISHING EARTH GRADED ROADS

Description.—This item shall consist of the final finish ready for traffic of the roadbed where an earth-graded road without surfacing other than earth or selected material is proposed; the work shall consist of shaping and dressing the roadbed to conform to the lines, grades, and typical cross section shown on the plans.

Construction methods.—After all earthwork has been substantially completed, all structures are complete, and all drains laid, the entire surface of the roadbed shall receive a finish shaping with grading machine, supplemented by hand work where necessary to secure a smooth surface and uniform cross section. All rock sections and all other sections where the natural material is not deemed suitable by the engineer shall be brought to grade by depositing to the depth authorized by the engineer a satisfactory cushion of selected material. This material shall be obtained in excavation or borrow and paid for as such, together with the necessary

overhaul on the same. The entire roadbed shall be brought to the final elevation and shape indicated on the plans and dressed as directed by the engineer. No roots, sod, or other deleterious matter, or stones that would fail to pass a 1½-inch ring shall be left within the top 4 inches of the finished road surface.

Basis of payment.—Finishing work, including the full width of the roadbed as constructed, shall be paid for at the contract unit price per mile bid for finishing earth-graded road, which price will include all equipment, tools, labor, and incidentals necessary to complete the work.

FINE GRADING SUBGRADE AND SHOULDERS

Description.—This work shall consist of preparing a previously graded road for immediate placement of surface courses or pavements. No work will be done or paid for under this item unless prices for same are requested in the proposal; otherwise all work described under this item shall be understood to be covered and compensated for as hereinbefore stated under common excavation, subgrade and shoulders.

Construction methods.—All slides shall be removed and the existing roadbed shall be scarified, if directed, bladed and shaped to conform accurately to the line, grade, and cross section shown on the plans. Should there develop any depressions or narrow embankments, sufficient approved earth material shall be obtained and placed, as common excavation, unclassified excavation, or borrow, to bring the surface of the roadbed, including the shoulders, to the exact lines, grades, and cross section shown on the plans. The roadbed shall then be rebladed and reshaped. The subgrade shall be compacted as provided in the specifications for subgrade, and all work done necessary to produce a completed and acceptable foundation for the placement of the surface course or pavement.

Method of measurement.—The quantity of fine grading of subgrade and shoulders to be paid for shall be the number of miles of roadbed approved and completed, measured along the center line.

Basis of payment.—The removal of all slides in excess of 5 cubic yards per station and furnishing and hauling the additional earth material mentioned above in excess of 5 cubic yards per station shall be paid for by the cubic yard at the unit prices bid for unclassified excavation, common excavation, or borrow. All other work covered by the specifications for this item shall be included in the price bid per mile for fine grading of subgrade and shoulders, which price shall be full compensation for shaping, dressing, and compacting the subgrade and shoulders, all as prescribed in the specifications thereof, and for all equipment, tools, labor, and incidentals necessary to complete the work, provided further, whenever provision is not made in the proposal for the removal of slides, and furnishing and hauling additional earth material mentioned above, then such work shall be considered as a part of the fine grading subgrade and shoulders and included in the bid price for the same.

SURFACE COURSES

TWO-COURSE CRUSHED ROCK OR CRUSHED GRAVEL SURFACE COURSE

Description.—This item shall consist of two courses, as indicated on the typical cross section, composed of crusher-run stone or gravel, and binder, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

Material.—Crushed stone for this work shall be crushed from sound, tough, durable rock and shall be uniform in quality and well graded. Crushed gravel, when used, shall meet the above specifications.

Bottom course material shall consist of crusher-run material passing a screen with circular openings of 1½ inches, and shall contain not more than 25 per cent of material passing a ¼-inch opening, which fraction shall comply with the grading requirements for binder.

Top course material shall consist of crusher-run material passing a screen with circular openings of ¾ inch, and it shall contain not more than 35 per cent of material complying with the grading requirements for binder.

Binder shall consist of the finer products of the crusher, or sand, and of suitable clay or silt. Binder shall all pass a screen having ¼-inch openings, at least 40 per cent shall be retained on a No. 30-mesh sieve, and 15 to 35 per cent of it shall pass a 200-mesh sieve.

Method of construction.—In handling and placing all graded materials for this work, care shall be taken to prevent separation of the fine from the coarse materials and such separation shall be cause for rejection in the discretion of the engineer. In no case shall binder material be taken from embankments, shoulders, or slopes.

The bottom course shall be spread in a uniform layer on the prepared subgrade to such a depth that when compacted the compacted depth will be as shown on the plans. This work shall begin at the point nearest the source of supply. Where binder is required it shall be uniformly spread after a distance of approximately 2,000 feet of surfacing has been hauled and spread. The surfacing and binder shall then be thoroughly mixed by alternately blading the material into windrows in the middle and back to the edges of the subgrade until the material shall be uniform throughout. A heavy tightly articulated grader with at least an 8-foot blade pulled by adequate mechanical power shall be used for this operation. When uniform the material shall again be carefully spread over the subgrade. Hauling shall be done over the surfacing material already deposited to compact it, accompanied by constant blading and dragging; care shall be taken to fill all ruts caused by hauling, to prevent formation of corrugations and waves in the longitudinal profile of the surface course and to avoid segregation of the material into nonuniform layers or into patches of coarse or fine material. The hauling shall be distributed so far as practicable in order to produce uniform and thorough compaction of the surfacing material. During these operations whenever small areas lacking in binder develop, binder shall be added and evenly incorporated by harrowing or equivalent means, to produce a dense surface metaling, complying with the grading requirements and completely bonded.

Watering.—During compaction water shall be applied as the engineer shall direct. The normal amount, unless otherwise directed, shall be a total of 60 gallons per cubic yard of material.

Rolling.—When required, rolling shall be done with a roller of self-propelled type, having a weight of at least 400 pounds per lineal inch of tire. A roller shall not be furnished on a project until authorized in writing. Rolling shall begin at the sides and progress toward the center line, overlapping at each succeeding passage.

When the bottom course is satisfactorily compacted, in the opinion of the engineer, the top-course material shall be similarly spread, watered, bonded, and compacted in two layers, and each layer treated as previously described. Supplemental crushed rock shall meet the specifications for top course and will be deposited in piles along the roadway as directed by the engineer.

After the top course has been completed in the manner specified, the contractor shall shape and finish the entire roadbed, including gutters and shoulders, so as to produce a uniformly crowned cross section as shown on the plans and strictly conforming to the profile grade. The gutters shall be cleaned and all excess material, loose stones and rock fragments that may be dragged to the surface or loosened shall be deposited on embankment slopes or as directed by the engineer. Until final acceptance the whole surface shall be bladed and dragged as often as necessary to assist in thorough compaction and to maintain it smooth and true to grade and cross sections.

Standard road planers, as shown on page 46, shall be used for performing the dragging required on this work and shall be left on the project upon completion of the work. The cost of furnishing these planers will be considered as a part of the cost of surfacing and will be considered as covered by the bid prices for the respective items for this work.

Method of measurement.—Crushed rock or gravel surface course material shall be measured by the cubic yard in the vehicle at the point of delivery on the road. Binder shall not be measured when available at the roadside within 500-foot haul. Binder furnished and hauled as directed more than 500 feet shall be measured in the vehicle at the point of delivery.

Basis of payment.—This surface course shall be paid for at the prices bid for the following items:

Crushed rock or crushed gravel bottom course, per cubic yard.
Crushed rock or crushed gravel top course, per cubic yard.
Supplemental crushed rock or crushed gravel, per cubic yard.
Binder hauled over 500 feet, per cubic yard-mile.
Providing and maintaining water plant or plants on the job, a lump sum.
Watering as required, per 1,000 gallons.
Providing and maintaining roller on the job, a lump sum.
Operation of roller for days actually operated only, including operator, oil, gas, coal, etc., per day.

These bid prices shall be full compensation for furnishing, hauling, and placing all material, and for all equipment, tools, labor, and incidentals necessary to complete the work.

ONE-COURSE CRUSHED ROCK OR CRUSHED GRAVEL SURFACE COURSE

Description and method of construction.—This work is identical with two-course crushed rock and crushed gravel surface course, save that it shall be constructed in one course and all work and material shall in all respects conform to that prescribed for the top course of the two-course item, which course shall be constructed on the prepared sungrade in accordance with the specifications and in conformity with the lines, grades, and cross sections shown on the plans.

Method of measurement and basis of payment.—The method of measurement and basis of payment shall be as prescribed for the two-course crushed rock or crushed gravel surface course, save that the bottom-course price will not apply.

TWO-COURSE GRAVEL SURFACE COURSE

Description and method of construction.—This item shall consist of work and material conforming to all the requirements for the work and material of the two-course crushed rock or crushed gravel surface course, save that the material for gravel surface may be natural or uncrushed material. The finished work shall conform to the lines, grades, and cross sections shown on the plans.

Method of measurement.—This work shall be measured as provided for the two-course crushed rock or crushed gravel surface course.

Basis of payment.—This work shall be paid for at the prices bid for the following items:

Gravel for bottom course, per cubic yard.
Gravel for top course, per cubic yard.
Supplemental gravel, per cubic yard.
Binder hauled over 500 feet, per cubic yard-mile.

Watering and rolling and equipment therefor shall be paid for as prescribed under two-course crushed rock or crushed gravel surface course.

STRUCTURES

CONCRETE BRIDGES

Description.—All concrete bridges shall be built as indicated on the plans, conforming to line, grade, and dimensions shown, and in accordance with the specifications for piling, concrete, reinforcing steel, and other items which constitute the complete structure.

Materials used shall be those prescribed for the several items which constitute the structure.

General construction methods.—All foundations shall be prepared as hereinbefore specified under excavation for structures, and they shall be inspected and approved by the engineer previous to placing any concrete. All foundations shall be poured in the "dry" except as provided in the special provisions or upon written permission by the engineer.

Method of measurement.—The quantities of the various items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

Basis of payment.—The measured quantities, as provided above, will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all materials, and for all labor, equipment tools, and necessary incidentals. Such payment shall constitute full payment for the completed structure, ready for use, and no additional allowance will be made for cofferdam construction, false work, form lumber, or other erection expenses.

TIMBER STRUCTURES

Description.—All timber structures shall be built as indicated on the plans, conforming to line, grade, and dimensions shown, and in accordance with the specifications for piling, concrete, untreated timber, treated timber, wearing top, and other items which constitute the complete structure.

Material.—(*a*) *Standard size and dressing.*—Rough timbers sawed to standard size shall be interpreted to mean that sawn rough timber shall not be over ¼ inch scant from the actual size specified. For instance, a 12 by 12 inch timber shall measure not less than 11¾ by 11¾ inches. Standard dressing shall be interpreted to mean that not more than ¼ inch shall be allowed for dressing each surface. For instance, a standard 12 by 12 inch timber, dressed four sides, shall measure not less than 11½ by 11½ inches.

(*b*) All timber shall be graded in conformity to the American Lumber Standards as contained in Simplified Practice Recommendation No. 16 issued by the Bureau of Standards, United States Department of Commerce, dated 1926.

Columns, sills, wheel guards, timber bumpers at ends of concrete spans, bulkhead sheeting, and bracing shall meet the requirements of the common structural grade.

Truss members, floor beams, stringers, caps, and flooring shall meet the requirements of the dense select structural or select structural grade as specified on the plans. When reduced working stresses are used in the design and it is so specified on the plans, the common structural grade will be allowed for these members.

Rails and rail posts shall meet the requirements of grade D select or No. 1 common as specified.

(*c*) *Untreated timber.*—All untreated timber shall show at least 85 per cent heartwood on any girt.

(*d*) *Treated timber.*—Timber treated by a pressure method to retain the quantity of preservative per cubic foot as hereinafter specified and so treated that all sapwood is entirely impregnated with creosote oil shall fulfill the requirements for untreated timber except there shall be no heartwood requirement.

Preservative treatment.—Timber to be treated for preservation shall be cut and framed prior to treatment. After treatment no unnecessary cutting of treated piles or timber will be allowed.

The range of pressure, temperature, and time duration shall be controlled so as to result in maximum penetration by the quantity of preservative injected, which shall permeate all of the sapwood and as much of the heartwood as practicable. The manner of treatment shall be as shown on the plans.

The treatment shall fulfill the following requirements:

Form of product and service	Preservative (A. W. P. A. specifications)	Minimum absorption, pounds per cubic foot		Specifications for treatment (A. W. P. A. specifications unless otherwise stated)
		Empty cell treatment	Full cell treatment	
Piling (for land or fresh water use exclusive of Douglas fir).	Creosote	8	16	Standard specifications for the preservative treatment of yellow pine piles by pressure processes. (A. W. P. A. Proc. 1924, pp. 223–226.)
Piling (Douglas fir for land or fresh water use).	do		10	A. W. P. A. marine piling committee specifications (1922 proceedings, pp. 401–409).
Structural timber of 5-inch thickness or more (except Douglas fir).	do	8	16	Standard specifications for the preservative treatment of timber by pressure processes.
Structural timber of 5-inch thickness or more (Douglas fir).	do	8	12	Standard specifications for the preservative treatment of Douglas fir ties by pressure processes.
Structural timber of less than 5-inch thickness (except Douglas fir).	do	10	22	Standard specifications for the preservative treatment of timber by pressure processes.
Structural timber of less than 5-inch thickness (Douglas fir).	do	10	18	Standard specifications for the preservative treatment of Douglas fir ties by pressure processes.

Creosote of American Wood Preservers' Association, grades 1, 2, or 3, or creosote coal tar solution will be satisfactory. Bidder must specify which grade he proposes to furnish.

Where initials A. W. P. A. are used, the intent is to refer to the American Wood Preservers' Association.

Bridge iron.—Steel truss rods, structural shapes, and plates shall conform to the requirements of the standard specifications for structural steel for bridges of the American Society for Testing Materials, serial designation A7–24. No welds in truss rods will be permitted. All plates or shapes which are heated to facilitate bending shall be properly annealed. Steel castings shall conform to the requirements of the standard specifications for steel castings of the American Society for Testing Materials, serial designation A27–24, and shall be class B medium grade. Iron castings shall conform to the requirements of the standard specifications for gray iron castings of the American Society for Testing Materials, serial designation A48–18.

Method of construction.—Treated timber shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

All places where the surface of treated timber is broken by cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar pitch.

Pile caps shall be level and have full even bearing on all piles in the bent and be secured to each pile by a ¾-inch diameter driftbolt extending at least 9 inches into the pile.

Truss and bent timbers shall be accurately cut and framed to a close fit in such manner that they will have even bearing over the entire contact surface of the joint. No blocking or shimming of any kind will be allowed in making joints, nor will open joints be accepted. Mortises shall be true to size for their full depth and tenons shall make snug fit therein.

All bolt holes shall be bored with an auger $\frac{1}{16}$ inch smaller in diameter than the diameter of the bolt. Holes for tension rods shall be bored with an auger $\frac{1}{16}$ inch larger in diameter than the diameter of the rod and the hole after the insertion of the rod shall be effectively sealed with hot pitch or other suitable waterproof material. Mortises and tenons shall be draw bored.

Stringers shall be sized at bearings. Outside stringers may have butt joints but interior stringers shall be framed to bear over the full width of floor beam or cap at each end. The ends shall be separated at least one-half inch for the circulation of air and shall be securely fastened to the timber on which they rest.

Roadway floors shall be of the strip or laminated type. Floor plank shall have a nominal thickness of 2 inches and the width shown on the plans. Unless otherwise specified, they shall be sized on one edge to a uniform width and shall not vary in thickness from end to end. Planks shall be full length and no splicing will be allowed. Planks shall be laid with the surfaced edge down and each 2-inch piece shall be toenailed to each stringer with 20d nails. The nailing of successive planks shall be staggered so that the spacing of nails along each stringer shall be not less than 4 inches. In addition each piece shall be nailed horizontally to adjacent pieces with 40d nails at 18 inches center to center and staggered both horizontally and vertically with nails in adjacent pieces. All floors shall be cut to a straight line along the sides of the roadway.

Wheel guards shall be constructed as shown on the plans and shall be bolted to the outside stringers by a ¾-inch machine or hook bolt spaced not more than 5 feet center to center. All joints shall be lapped and a bolt shall pass through each lapped joint. When the wheel guard is not blocked up from the floor, drain holes shall be provided at such intervals as to adequately drain the roadway. They shall be provided with galvanized-iron lining and arranged so as to discharge free of the structure.

Railings shall be built as shown on the plans and shall be constructed in a workmanlike and substantial manner. All railing material shall be untreated and shall be surfaced on four sides. All rails shall be squarely butt jointed at the posts and the rails shall break joints.

Bolts shall be of the sizes specified and must be perfect in every respect. They shall have square or carriage heads and square nuts, and screw threads shall make close fits in the nuts. All bolts shall be effectually checked after the nuts are adjusted.

Washers shall be used between all boltheads and nuts and the wood. Cast washers shall have a thickness equal to the diameter of the bolt and a diameter of four times the thickness. For malleable or plate washers, the diameter or side size of the square shall be equal to four times and the thickness equal to one-half the diameter of the bolt.

When specified on the plans, all hardware, including nails, spikes, bolts, nuts, and washers, shall be galvanized. Cast-iron washers shall be used when the timber is in contact with earth.

Painting treated timbers.—Hot creosote oil shall be poured into the bolt holes before the insertion of the bolts in such a manner that the entire surface of the holes shall receive a coating of the oil. After the necessary cutting has been done to receive the cap, the heads of piles shall be given three coats of hot creosote oil. They shall then be covered with a coat of hot tar pitch over which shall be placed a sheet of 3-ply roofing felt or galvanized iron, or a covering may be built up of alternate layers of hot tar pitch and loose woven fabric similar to membrane waterproofing, using four layers of pitch and three of the fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile, and shall be bent down over the pile and the edges fastened with large headed nails, or secured by binding with galvanized wire. After the cover is in place the cap shall be placed and driftbolted as prescribed above.

Painting untreated timbers.—In structures of untreated timber, the following surfaces shall be thoroughly coated with a coat of thick red lead paint before assembling: Heads of piles, ends, tops and all contact surfaces of pile caps, floor beams, and stringer ends, joints, and all contact surfaces of truss members, laterals and braces. The back face of bulkheads and all other timber in contact with earth shall be thoroughly coated with two coats of thick red lead paint, hot tar, hot asphaltum, hot coal tar creosote or a carbolineum. Timber bumpers at the ends of concrete spans shall be painted on all faces with two coats of carbolineum after all holes have been bored and the timber shaped to fit the crown of the roadway.

Unless otherwise specified, handrailing and posts shall be painted with three coats of paint composed of three parts, by weight, of white lead to one part, by weight, of zinc oxide, uniformly

combined and mixed with pure linseed oil to the required consistency for priming or for second and third coat. Turpentine drier may be added to the paint but shall not exceed an average proportion of one half pint of drier to one gallon of paint. The white lead and zinc oxide shall be of a reputable and approved brand ground in oil, and shall be delivered separately on the project in the original containers before being opened or mixed with the linseed oil.

All timber to be painted must be seasoned, and painting shall be done only when the timber is free from frost and the surface is perfectly dry and clean. No painting shall be done in wet or freezing weather. All paint shall be thoroughly dry before applying the succeeding coats. It shall be applied in good heavy coats, completely covering every part of the surface, and shall be well worked into the joints and open spaces; it shall be so thoroughly and evenly spread that no excessive paint will collect at any point.

All bolts passing through nonresinous wood shall be painted with two coats of red lead paint at least 85 per cent pure.

Method of measurement.—Treated timber and untreated timber complete in place according to the plans and these specifications will be measured separately by the thousand feet board measure. Measurements will be computed from the dimensions shown on plans, unless changes in such dimensions have been authorized by the engineer. Standard timber sizes will be used in computations. This measurement will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, forms, bracing, sheeting, etc. Any concrete, or any supplementary floor wearing tops, shown on plans will be measured as provided in pertinent specifications.

Basis of payment.—Timber structures, except truss spans, will be paid for by the quantities as above measured at the contract unit price per thousand feet board measure bid for untreated timber or treated timber, as the case may be, complete in place according to the plans or as directed by the engineer, which prices shall be full compensation for all materials, hardware, equipment, tools, labor, painting, preservative treatment, and all incidentals necessary to complete the structure ready for use; provided, however, that concrete, or supplementary floor wearing tops shown on plans will be paid for as provided in the special provisions attached hereto.

Timber trusses complete will be paid for at the price bid per span complete, as shown on the plans, which shall include all parts of the bridge except abutments and piers. This price shall be full compensation for all materials, structural steel, steel or iron castings, hardware, equipment, tools, labor, painting, preservative treatment, and all incidentals necessary to complete the structure ready for use; provided, however, that supplementary floor wearing tops shown on the plans will be paid for as provided in the special provisions attached hereto. Timber bumpers at the ends of concrete spans will be paid for at the contract price bid for each wood bumper complete in place, which price shall include all material, bolts, washers, painting, preservative treatment, equipment, tools, labor, and all incidentals necessary to complete this item.

LOG BRIDGES AND TRESTLES

Description.—All log trusses and log trestles shall be built as indicated on the plans conforming in all respects to the line, grade, and dimensions shown and in accordance with these specifications.

Material.—The logs used in constructing log bridges shall be of the species specified on the plans, or if not therein specified, as required by the engineer. The logs may be obtained and the tops and branches of trees shall be disposed of as provided in the specifications for clearing and grubbing, as hereinbefore given.

The logs shall be straight, sound, out of wind, and free from defects of all kinds and shall be cut from live trees not less than 30 days in advance of use, but not exceeding 1 year, and be allowed to season with bark on. Immediately before use in the work all bark shall be peeled and the logs trimmed smooth of all knots and projections.

Steel truss rods, structural shapes and plates, steel and iron castings shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given.

All lumber for flooring, railings, etc., shall be of the kind and dimensions indicated on the plans and shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given.

The contractor shall furnish all necessary bolts, driftbolts, spikes, nails, and other material or hardware called for on the plans or in the specifications.

Construction methods.—The contractor shall provide experienced workmen and ample and suitable equipment and tools for performing the work and shall follow only well-recognized methods in preparing the timber and framing and erecting the structure. Where concrete or masonry piers or abutments are called for on the plans, they shall be constructed in accordance with the requirements of the plans and of the specifications herein given for the particular kind of concrete or masonry called for, and be paid for as thereunder prescribed.

The provisions for preservative treatment, bridge iron and methods of construction as specified for timber structures, shall apply to log bridges and log trestles.

Basis of payment.—Each log truss and log trestle span complete will be paid for at the price bid per span complete, as shown on the plans, which shall include all parts of the bridge except abutments, piers, and timber bents. This price shall be full compensation for all materials, bridge iron, hardware, equipment, tools, labor, painting, preservative treatment and all incidentals necessary to complete the structure ready for use; provided, however, that supplementary floor wearing tops shown on the plans will be paid for as provided in the special provisions attached hereto.

Log timber bents, including sills, columns, posts, and bracing, will be paid for at the contract unit price bid per lineal foot of log, as shown on the plans. This price shall be full compensation for all materials, hardware, preservative treatment, equipment, tools, labor, and incidentals required to construct and complete the bents in accordance with the plans and specifications. Sawed timber cross bracing will not be paid for separately and the price bid per lineal foot of log shall include this item.

LOG ABUTMENTS FOR BRIDGES

Log abutments for bridges will be built according to the specifications for log cribbing, and as shown on the plans, and will be paid for as log cribbing.

LOG CRIBBING

Description.—All log cribbing shall be built as indicated on the plans, conforming in all respects to the line, grade, and dimensions shown, and in accordance with these specifications.

Material.—The contractor shall secure and prepare all necessary logs, timber, hardware, etc., under the conditions and as called for under the heading material for log bridges.

Construction methods.—The cribbing shall be supported on mudsills, with flattened lower surfaces placed as shown on the plans. All logs, including face logs, tie logs, mudsills, and anchor logs, shall be properly notched together and driftbolted, as shown on the plans. The ends of the logs and all cut surfaces shall be treated with preservative as hereinbefore specified for timber structures.

The minimum lengths and sizes of logs shall be as shown on the plans. Each course of logs shall break joint with the adjacent courses. The lengths of tie logs required for the proper support and anchorage of the cribbing shall be as determined by the engineer.

The face and tie logs are to be so notched together, and hewn if necessary, that the face logs will be in contact with each other throughout their entire length, except that in case a satisfactory rock backing is placed against the face logs, the engineer may permit open spaces not exceeding 4 inches in width between the face logs. When permission to use such spaces is given, the rock back fill shall be carefully placed, using the larger rocks adjacent to the logs

and backing up with the smaller rocks in such manner that earth and finer material may not escape or be washed out.

Basis of payment.—Payment will be made at the unit price bid per square foot of crib face in place complete, which price shall include the furnishing and placing of transverse mudsills, tie logs, anchor logs, and driftbolts. Such unit bid price shall be full compensation for all materials, hardware, equipment, tools, labor, and incidentals required for the construction of the cribbing complete.

LOG CULVERTS

Description.—All log culverts shall be built as indicated on the plans, conforming in all respects with the line, grade, and dimensions shown, and in accordance with these specifications.

Materials and methods of construction shall be as prescribed for log bridges and log cribbing.

Method of measurement.—Log culverts shall be measured along the center line, and over-all length shall be taken.

Basis of payment.—Log culverts shall be paid for at the contract unit price bid per lineal foot of log culvert of the respective sizes as set forth in the proposal, which price shall be full payment for all material, equipment, tools, labor, and incidentals necessary to complete the work.

CULVERTS AND RETAINING WALLS

Description.—All concrete and masonry culverts, all pipe culverts, end walls, and retaining walls shall be built as indicated on plans, conforming to line, grade, and dimensions shown and in accordance with the specifications for concrete, masonry, pipe, of the several varieties, and other items which are to constitute the complete structures. For farm entrance crossings the minimum diameter of pipe shall be 12 inches. For roadway culverts the minimum diameter permitted shall be 18 inches. The maximum diameter permitted shall be 36 inches.

General construction methods.—All foundations shall be prepared as hereinbefore specified under excavation for structures, and they shall be inspected and approved by the engineer previous to placing any masonry or footing.

When pipe is of the bell and spigot type, the bell end of the pipe shall be laid upgrade and all joints shall be made water-tight with 1 to 2 Portland cement mortar in accordance with the standards of the American Society for Testing Materials. In refilling the pipe trench the material for back fill shall be free from large stones for a depth of 9 inches above the pipe and shall be placed carefully under and around the pipe and tamped to give the pipe a uniform bearing throughout. The ends of all pipe culverts shall be protected by concrete or masonry end walls unless otherwise shown on the plans or ordered by the engineer.

Method of measurement.—The quantities of the various items which constitute the completed and accepted structures will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

Basis of payment.—The measured quantities as provided above will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all material, all labor, equipment, tools, and necessary incidentals. Such payment shall constitute full payment for the completed structure ready for use.

CONCRETE

Description.—Concrete shall be composed of Portland cement, fine and coarse aggregate, and water, mixed as provided in these specifications, and shall be constructed where indicated and of the form and dimensions shown on the plans. Concrete will be classified according to the relative porportions of the three ingredients. The proportions of fine and coarse aggregate

specified may be varied slightly by the engineer to obtain concrete of maximum density, but the proportion of cement to the sum of the aggregates, measured separately, shall not be changed, except as provided herein. The class required for each part of the structure will generally be given on the plans; but if not given the following requirements shall govern:

Class A.—Class A concrete, composed of 1 part Portland cement, 2 parts fine aggregate, and 4 parts coarse aggregate, all by volume, shall be used for reinforced concrete and concrete deposited in water, except as hereinafter provided.

Class B.—Class B concrete, composed of 1 part Portland cement, 2½ parts fine aggregate, and 5 parts coarse aggregate, shall be used for plain concrete, except footings, and concrete deposited in water.

Class C.—Class C concrete, composed of 1 part Portland cement, 3 parts fine aggregate, and 6 parts coarse aggregate, shall be used for plain concrete footings, unless deposited in water.

Class D.—Class D concrete, composed of 1 part Portland cement, 2 parts fine aggregate, and 3 parts coarse aggregate, shall be used for railings, concrete pipe, bridge slabs, beams, girders, and curbs.

Materials.—*Portland cement.*—The cement used for this work shall be a standard brand of Portland cement and shall conform to the requirements and tests as provided in the United States Federal Board Master Specification No. 1 (Bureau of Standards Circular No. 33).

Water.—All water used in concrete shall be subject to the approval of the engineer, and shall be reasonably clear and free from oil, acid, or alkali and vegetable substances, and shall not be brackish nor salty. Water of doubtful quality shall be tested in briquets as hereinafter described in the Ottawa sand-mortar test, and the strength of such briquets shall be equal to similar briquets made of water of known satisfactory quality.

Fine aggregate for concrete.—The fine aggregate for concrete shall consist of sand or a combination of sand and stone screenings conforming to the following requirements:

All sand shall consists of clean, hard, durable, uncoated grains, free from lumps, soft or flaky particles, organic matter, loam, or other deleterious substances. Sand for reinforced concrete shall be free from salt and alkali.

All stone screenings shall consist of clean, dustless screenings, resulting from the crushing of tough, durable rock, having a per cent of wear of not more than 5. They shall be free from thin, elongated, or laminated pieces, disintegrated stone, vegetable or other deleterious matter. Screenings for reinforced concrete shall be free from salt and alkali.

Fine aggregate shall be well graded from coarse to fine, and, when tested by means of laboratory screens and sieves, shall meet the following requirements:

	Per cent
Passing ¼-inch screen	100
Passing a standard 20-mesh sieve	50–80
Passing a standard 50-mesh sieve	5–25
Passing a standard 100-mesh sieve, not more than	10
Weight removed by elutriation test, not more than	3

The fine aggregate shall be of such quality that mortar composed of 1 part of Portland cement and 3 parts of the fine aggregate, by weight, when made into briquets and tested in accordance with methods described in the United States Department of Agriculture Bulletin No. 1216, will show, at an age of 7 days, not less than the following tensile strength ratios when compared with simultaneous tests of briquets made at the same time from 1 to 3 mortar of the same consistency and composed of the same cement and standard Ottawa sand: Class A and D concrete, 100 per cent; class B and C concrete, 85 per cent; except that fine aggregate will be accepted where the strength ratio is not less than 70 per cent, subject to the use of additional cement. The percentage of additional cement required will be determined by laboratory tests and shall be that percentage required to increase the strength ratio to 100 per cent in the case of class A and D concrete, and to 85 per cent in the case of class B and C concrete.

Coarse aggregate for concrete.—The coarse aggregate for all classes of concrete shall consist of broken stone or gravel, all confroming to the respective requirements following:

Broken stone shall be obtained from clean, tough, durable rock having a per cent of wear of not more than 5, and shall be free from thin, elongated, or laminated pieces, soft or disintegrated stone, vegetable, or other deleterious substances. Broken stone for reinforced concrete shall be free from salt and alkali.

Gravel shall consist of clean, hard, and uncoated pebbles of high resistance to abrasion. Gravel for reinforced concrete shall be free from salt and alkali.

Coarse aggregate shall be well graded from the maximum size to pieces one-quarter inch in diameter. The maximum size will generally be given on the plans, but if not given the following shall govern:

For class A concrete the aggregate shall have a maximum size not greater than will pass a screen having circular openings 1½ inches in diameter, except that for walls and slabs less than 8 inches thick the aggregate shall have a maximum size not greater than will pass a screen having circular openings 1 inch in diameter; for class B and class C concrete the aggregate shall have a maximum size not greater than will pass a screen having circular openings 3 inches in diameter; and for class D concrete the aggregate shall meet the requirements for class A concrete hereinbefore given, except that for the railings and concrete pipe the aggregate shall all pass a screen having circular openings ¾ of an inch in diameter

When tested by means of laboratory screens, coarse aggregate shall meet the following requirements:

Percentage of coarse aggregate passing the various laboratory screens

Maximum size of aggregate	3-inch	2½-inch	2-inch	1½-inch	1¼-inch	1-inch	¾-inch	½-inch	Passing screen having circular openings ¼ inch in diameter, not more than—
3	100			40–75					10
2½		100			40–75				10
2			100			40–75			10
1½				100			40–75		10
1¼					100			35–70	10
1						100		40–75	10
¾							100		10

Fine and coarse aggregate not conforming to the above grading requirements may be used with the approval of the engineer, provided the concrete proportions are altered to give the following required minimum crushing strength:

	Class A (normally) 1:2:4	Class B (normally) 1:2½:5	Class C (normally) 1:3:6	Class D (normally) 1:2:3
Strength per square inch, 7 days	1, 300	1, 100	900	1, 400
Strength per square inch, 28 days	2, 000	1, 600	1, 300	2, 200

In no case, however, shall fine aggregates be used which contain more than 3 per cent, by weight, of material removable by the elutriation test. Only such proportions shall be used as will produce a workable mixture and a dense concrete. If the specimens fail to fulfill requirements for 7-day tests, the aggregate may be accepted if specimens will fulfill requirements for the 28-day tests.

The fine and coarse aggregates shall be sampled and tested in accordance with the method described in United States Department of Agriculture Bulletin No. 1216.

The concrete for testing purposes shall be made with the fine and coarse aggregate and cement proposed to be used on the work, and the concrete shall be mixed to the same consistency as will be used in construction.

Rubble one-man stone may be embedded in class B or class C concrete when shown on the plans, or when the same is a plain mass concrete of more than 2 feet in thickness, and allowed by the engineer. These stones shall not be placed within 6 inches of any finished surface of the concrete and shall be placed at least 6 inches apart. The stone for this purpose shall consist of clean, sound, rubble stone, free from structural defects, foreign substances, and coatings of any character, shall be laid on their natural bed, and shall be washed and of a quality satisfactory to the engineer.

Method of construction.—Falsework shall be built on good, firm foundation and be of sufficient strength to carry the loads without appreciable deformation. For single spans it shall be constructed with $\frac{1}{20}$ of 1 inch camber for each foot of span, and for multiple spans it shall be constructed with $\frac{1}{30}$ of 1 inch camber for each foot of span. If appreciable settlement occurs in the falsework, the engineer shall stop the work and require a thorough remodeling to insure a first-class product. In long spans, the engineer may require the contractor to use wedges to take up any slight settlement in the form work either before or during the placing of concrete.

For continuous girders and arches, detail drawings of the falsework shall be submitted to the engineer for approval. Arch centering shall be so constructed as to permit of its being gradually and uniformly lowered or released after pouring the arch ribs.

Forms shall be so designed and constructed that they may be removed without injuring the concrete.

The material to be used in the forms for exposed surfaces shall be sized and dressed lumber or metal in which all bolt and rivet heads are countersunk, so that in either case a plain, smooth surface of the desired contour is obtained. Undressed lumber may be used for backing or for surfaces which will not be exposed in the finished structure. The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar-tight and shall be thoroughly soaked with water before and throughout the pouring of concrete. Forms for reentrant angles shall be chamfered and for edges shall be filleted. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled or greased to insure the nonadhesion of mortar. Form lumber if used a second time shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete, any bulging or warping shall be remedied, and all dirt, sawdust, shavings, or other débris within the forms shall be removed.

All materials shall be measured accurately by volume. The cement shall be measured as packed by the manufacturer, a sack containing not less than 94 pounds net being considered 1 cubic foot. When broken bags of cement are used, the cement for each batch shall be accurately measured. Fine and coarse aggregate shall be measured loose. The contractor shall furnish and use an approved water measuring and discharging device, also boxes or pans of such dimensions as will give, when filled and struck, the exact volume of aggregate required for the class of concrete specified.

Sufficient water shall be used in mixing plain concrete to produce a mixture which will flatten and quake when deposited in place, but not enough to cause it to flow; and in mixing concrete in which reinforcement is to be embedded sufficient water shall be used to produce a mixture which will flow sluggishly when worked and which at the same time can be conveyed from the mixer to the forms without separation of the coarse aggregate or water from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms.

In general, a mixture shall be used which contains the minimum amount of water consistent with the required workability. If required by the engineer, the consistency of the concrete shall be measured by the slump test in accordance with the methods described in the United States Department of Agriculture Bulletin No. 1216. The slump for the different types of concrete shall not be greater than as follows:

	Inches
Mass concrete	3
Reinforced concrete:	
(*a*) Heavy or medium sections, including slabs, curbs, beams, girders, columns, walls, etc., where tamping and spudding can be readily done	3
(*b*) Medium or light sections, including columns, piers, walls, etc., where tamping and spudding are difficult	5
(*c*) Light sections, including handrail and sections where tamping and spudding are impossible	7

These values may be modified slightly at the discretion of the engineer on account of difficulties in tamping and spudding or concentration of reinforcing steel as in the bottom of beams and girders.

The concrete shall be mixed in the quantities required for immediate use, and any which has developed initial set, or which is not in place in the forms within 30 minutes after the water has been added, shall not be used. No retempering will be allowed. No concrete shall be mixed while the air temperature is at or below 35° F. without the approval of the engineer, and only when adequate means are employed to heat the aggregates and water.

Unless hand mixing is specifically permitted by the engineer, the mixing shall be done in a batch mixer of approved type which will insure the uniform distribution of the materials throughout the mass so that the mixture is uniform in color and smooth in appearance. The mixing shall continue for a minimum time of one and one-half minutes after all the ingredients including water, are assembled in the drum, during which time the drum shall revolve at the speed for which it was designed, but shall make not less than 14 nor more than 20 revolutions per minute. The mixer shall be equipped with an attachment for satisfactorily locking the discharging device so as to prevent the emptying of the mixer until all the materials have been mixed for the minimum time required. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

When hand mixing is permitted, it shall be done on a water-tight platform. The fine aggregate and cement shall first be mixed until a uniform color is attained and then spread over the mixing board in a thin layer. The coarse aggregate, which shall have been previously drenched, shall then be spread over the fine aggregate and the cement in a uniform layer and the whole mass turned as the water is added. After the water has been added, the whole mass shall be turned at least six times, and until the mixture is uniform in color and smooth in appearance. Hand-mixed batches shall not exceed ½ cubic yard in volume.

Concrete shall be placed in the forms immediately after mixing in horizontal layers not over 12 inches in depth. It shall be so deposited that the aggregates are not separated. Dropping the concrete any considerable distance, depositing large quantities at any point and running or working it along the forms, or any other practice tending to cause segregation of the ingredients will not be allowed. It shall be compacted by continuous tamping, spading, or slicing. Care shall be taken to fill every part of the forms, to work the coarser aggregate back from the face, and to force the concrete under and around the reinforcement without displacing it. Mass concrete shall be deposited in continuous horizontal layers, and, whenever practicable, all concrete in structures shall be deposited continuously for each monolithic section of the work.

Concrete shall be deposited in water only with the permission of the engineer and under his supervision. When depositing in water is allowed, the concrete shall be carefully placed in the space in which it is to remain in a compact mass by means of a tremie, bottom-dumping bucket, or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being deposited.

No concrete shall be placed in running water, and forms which are not reasonably water-tight shall not be used for holding concrete deposited under water.

Concrete shall not be placed when freezing temperature prevails or threatens, except upon written permission from the engineer, which will not be granted until satisfactory provision has been made for heating the water and aggregate. In general, the temperature of the mixed concrete shall not be less than 60° F. at the time of placing in the forms.

All bolts necessary to secure timber bumpers at the ends of concrete spans shall be set in the concrete as shown on the plans at the time of pouring the concrete deck.

Construction joints.—Whenever the work of placing concrete is delayed until the concrete shall have taken its initial set, the point of stopping shall be deemed a construction joint. So far as possible the location of construction joints shall be planned in advance and the placing of concrete carried continuously from joint to joint. These joints shall be perpendicular to the principal lines of stress and in general be located at points of minimum shear. No joints shall be made with the concrete sloping to a thin edge. Bulkheads shall be used in all joints other than horizontal.

Where dowels, reinforcing bars, or other adequate ties are not shown on the plans or required by the engineer, keys shall be made by embedding water-soaked beveled timbers of a size shown on the details, or as directed by the engineer, in the soft concrete, which shall be removed when the concrete has set. In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft material, with stiff wire brushes, and, if deemed necessary by the engineer, shall be roughened with a steel tool. The surface then shall be thoroughly washed with clean water and painted with a thin coat of neat cement mortar, after which the concreting may proceed.

No concrete work shall be stopped or temporarily discontinued within 18 inches of the top of any finished surface, unless such work is finished with a coping having a thickness less than 18 inches, in which case the joint shall be made at the under line of the coping.

Expansion joints.—Expansion and contraction of concrete structures shall be provided for by expansion joints as shown on the plans. Care should be taken in construction that these joints are so made as to permit a free movement at the joint when the concrete expands or contracts.

Curing concrete.—Handrails, floors, and troweled surfaces shall be protected from the sun, and in drying weather the whole structure shall be kept wet for a period of 10 days. For concrete requiring finishing, the surface shall be kept moist until finishing is complete. Concrete floor slabs shall be covered with damp sand as soon as the concrete has taken hard set and then kept wet for 10 days. The covering material shall not be cleared from the surface of the floor for a period of 21 days, during which time no traffic shall pass over the structure. Other precautions to insure thorough curing of the concrete shall be taken by the contractor as directed by the engineer.

During freezing weather the concrete shall be thoroughly protected until set, and, if required by the engineer, provisions for heating the concrete shall be provided in such a way that the air surrounding the fresh concrete will be kept at a temperature about 50° F. for a period of five days after the concrete is placed. Concrete placed under these conditions will not be accepted until after 30 consecutive days during which the temperature does not fall below 40° F.

Removal of forms.—In order to make possible the obtaining of a satisfactory surface finish, forms on ornamental work, railings, parapets, and exposed vertical surfaces shall be removed in not less than 12 nor more than 48 hours, depending upon weather conditions. Forms under slabs, beams, girders, and arches shall remain in place at least 21 days in warm weather, and in cold weather at the discretion of the engineer. Forms shall always be removed from columns before removing shoring from beneath beams and girders, in order to determine the condition of concrete in the columns.

No forms whatever shall be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. As soon as the forms are removed all bolts, wires, or other appliances which hold the forms and which pass through the concrete shall be cut off or set back ½ inch below the surface in such a manner as not to disturb the concrete more than ¼ inch around the hole. Lips of mortar and all irregularities caused by form joints shall be removed. The presence of excessive honeycomb areas may be considered sufficient cause for the rejection of the structure, and upon written notice from the engineer the contractor shall remove and rebuild the structure at his own expense. In patching holes or porous spots, all coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse aggregate is obtained. Feathered edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement mortar shall be applied. The cavity shall then be filled with a thick mortar composed of one part of Portland cement to two parts of sand which shall be thoroughly tamped into place. The surface of this mortar shall be floated with a wooden float before initial set takes place, and shall present a neat and workmanlike appearance.

For patching large or deep areas, coarse aggregate shall be added to the patching material if ordered by the engineer, and special precautions shall be taken to insure a dense, well-bonded and properly cured patch, as required by the engineer.

Finishing concrete.—All concrete surfaces shall be reasonably true and even, free from stone pockets, excessive depressions or projections beyond the surface. Concrete floors shall be struck off with a templet immediately after pouring to provide the proper crown, and shall be hand finished to a smooth even surface by means of wood floats, or other suitable means. The finished surface shall not show a variation of over ¼ inch in 10 feet using a 10-foot straightedge placed parallel to the center line of roadway, and no variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The concrete bridge seats and tops of walls and curbs shall be brought flush with the finished top surface and struck off with a straightedge and floated. All exposed surfaces which shall include bottom of overhung or cantilever portions of slabs, bottom, and outside of exterior beams or girders, faces of abutments or walls above a point 1 foot below the ground or fill line and all sides of curbs, handrails, columns, arch ribs, and struts, shall be finished by rubbing with a carborundum stone, except that when the forms can be removed while the concrete is still green, the concrete may be finished by floating with a wooden float. When a carborundum stone is used, a thin rich grout composed of fine sand and cement shall be spread over a small area of the surface and immediately followed by rubbing with the stone. The lather resulting from the rubbing shall be left on the surface and brushed uniformly over the entire surface. The surface shall be finished so that all irregularities and form marks are removed, leaving a smooth uniform surface. A cement wash or plaster coat shall not be used.

Method of measurement.—All concrete conforming to the specifications and plans and placed as directed shall be measured by the cubic yard. In computing the concrete yardage for payment, the dimensions used shall be those shown on plans or ordered in writing by the engineer. No measurements or other allowances will be made for work or material for forms, false work, cofferdams, pumping, bracing, etc.

Basis of payment.—Payment will be made for the yardage of concrete measured as prescribed above at the contract unit price bid per cubic yard for class A, class B, class C, or class D concrete. Such payment will be full compensation for all materials, forms, false work, equipment, tools, labor, and incidentals necessary to complete the item, except that steel reinforcement will be paid for as a separate item.

REINFORCING STEEL

Description.—Under this item reinforcing steel, consisting of plain or deformed bars, or of steel mesh or expanded metal, shall be furnished and placed as called for on the plans or as directed. When deformed bars are specified, the form of the bars used must be approved by the engineer and shall be such as to provide a net section at all points equivalent to that of a plain square or round bar of equal nominal size. The use of cold twisted bars will not be permitted. Steel mesh and expanded metal shall only be used when specified and shall be of the type shown on plans and approved by the engineer.

Material.—Reinforcing bars shall meet the requirements of the standard specifications for billet steel concrete reinforcement bars of structural steel, intermediate or hard grade, serial designation A15–14, or rail steel concrete reinforcement bars, serial designation A16–14, of the American Society for Testing Materials, except that in structures of 20-foot span or less new billet hard grade steel and rerolled rail steel may be used only in sizes not greater than ¾ inch square and shall in all cases be bent cold.

Where purchased from warehouse in small lots, reinforcement may, at the direction of the engineer, be accepted subject to the bending test.

Steel mesh or expanded metal shall be manufactured from material fulfilling the requirements of the Standard Specifications of the American Society for Testing Materials for billet steel concrete reinforcement bars serial designation A15–14.

Method of construction.—When placed all reinforcement shall be free from dirt, oil, paint, grease, mill scale, loose or thick rust.

When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected. All reinforcement shall be placed in the exact position shown on the plans, and shall be so securely held in position by wiring to and blocking from the forms and by wiring together at intersections that it will not be displaced during depositing and compacting of the concrete. Precast concrete blocking should be used where applicable.

Placing and fastening of reinforcement in each section of the work shall be approved by the engineer before any concrete is deposited in the section.

When bar-bending diagrams are not shown on the contract plans, detail plans showing the bending of reinforcing bars shall be submitted to the engineer for approval.

Splicing reinforcement.—Whenever it is necessary to splice reinforcement at points other than those shown on the plans, drawings showing the location of each splice shall be submitted and approved by the engineer before the reinforcing steel is ordered. Splices shall be avoided at points of maximum stress; they shall, where possible, be staggered, and shall be designed to develop the strength of the steel without exceeding the allowable unit bond stress.

Determination of weight.—The weight of steel to be paid for shall be the theoretical weight of the steel placed as shown on the plans and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars, as the case may be, of equal nominal size. If steel mesh or expanded metal is required, the weight per square foot will be shown on plans.

Basis of payment.—The weight of steel thus determined shall be paid for at the contract unit price bid for reinforcing steel described on plans, which price shall be full compensation for furnishing the material, all equipment, tools, labor, and incidentals necessary to complete the item. No allowance will be made for the clips, wire, separators, or other material used for fastening the reinforcing steel in place.

PHOSPHOR BRONZE AND BRONZE BEARING PLATES

Description.—Phosphor bronze or bronze bearing plates, conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed.

Material.—Phosphor bronze and bronze bearing plates shall meet the requirements for bronze bearing metals for turntables and movable railroad bridges, serial designation B22–21, of the American Society for Testing Materials. Bronze castings shall be free from inclusions of foreign material, casting faults, injurious blowholes or other defects rendering them unsuitable for the service intended.

Construction methods.—Bearing plates shall be accurately set in correct position as shown on the plans and shall have uniform bearing over the total area. They shall be securely anchored to the concrete with bolts set in the concrete of the size and as shown on the plans. Sliding surfaces shall be planed parallel to the movement of the spans and polished and shall be thoroughly coated with graphite and grease just before being placed in position, and special care shall be taken to avoid placing concrete in such a manner as to interfere with their free action.

Basis of payment.—Payment will be made at the contract unit price bid per pound for phosphor bronze or bronze bearing plates complete in place, which price will be full compensation for furnishing material including bolts, all equipment, tools, labor, and incidentals necessary to complete the item.

STRUCTURAL STEEL

Description.—Structural steel complying with the dimensions and shape prescribed on the plans shall be furnished and placed as shown thereon in accordance with the special provisions attached hereto.

CEMENT RUBBLE MASONRY

Description.—Cement rubble masonry shall be composed of approved stones laid in mortar beds and shall be constructed in conformity with the plans or as directed in writing by the engineer.

Material.—The Portland cement, sand, and water for the mortar shall be such as to conform with the respective requirements for these materials as contained in the specifications hereinbefore given for concrete.

The stone for rubble masonry shall be clean, hard, and of a kind known to be durable. All weathered stone shall be rejected. The individual stones, except for filling joints, shall have a thickness of not less than 5 inches and a width of not less than one and one-half times the thickness nor less than 12 inches. No stone, except headers, shall have a length less than one and one-half times its width.

Construction methods.—All rubble masonry shall be constructed by experienced workmen. Selected stones, roughly squared and pitched to lines, shall be used at all angles and ends of walls. All stones shall be thoroughly wet prior to laying and be laid with practically horizontal beds. Large flat stones shall be selected for the bottom course. All stones shall be fully bedded in Portland cement mortar, mixed in the proportion of 1 part cement to 3 parts of sand and shall be so placed as to break joints at least 6 inches and form a firm bond. Mortar which is not used within 30 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted.

For mortar the sand and cement shall first be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains a consistency such that it can be easily handled and spread with a trowel.

Headers shall be distributed uniformly through the walls of the structures so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend through the face wall into the backing at least 12 inches, and where a wall is less than 18 inches in thickness the headers shall extend entirely through from front to back face.

The interior of the walls shall be built up so that the stones of which it is composed will be bonded, and so that no open spaces will be left. Horizontal joints in the face shall not exceed 1 inch in thickness and vertical joints shall not exceed 2 inches in width. No spalls shall be used in the face of a wall, and the face stones shall be so well bedded that none will be needed. Walls shall be provided with weep holes wherever called for on the plans or directed by the engineer.

If a stone is loosened after the mortar has set it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

This class of masonry shall be finished with a concrete coping or with a top course consisting of roughly shaped stones. Bridge seats and back walls, unless otherwise specified, shall be of class A concrete, which shall be not less than 8 inches thick and wide enough to cover the full width of the wall and shall be cast in place. If a stone coping is specified, the stones shall be not less than 8 inches thick, from 1½ to 4 feet long and wide enough to cover the top of the wall, set in full mortar beds as shown on the plans.

After the stone is all laid as above specified the face joints shall be thoroughly cleaned of all mortar to a depth of 1 inch. The joints shall then be wetted and pointed with Portland cement mortar, mixed in the proportion of 1 part of cement to 1 part of sand. No pointing shall be done in freezing weather, and any work damaged by frost shall be removed and replaced. In hot or dry weather the pointed masonry shall be satisfactorily protected from the sun and kept wet for a period of three days after completion.

No masonry shall be laid in freezing weather without the permission of the engineer and the the use of such precautions as he may direct to be taken. In hot or dry weather the masonry shall be protected from the sun for at least three days after laying.

Basis of payment.—This work shall be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the engineer, and will be paid for at the unit price bid per cubic yard for cement rubble masonry complete in place, which price will be full compensation for the concrete coping or stone top course, whichever is required, for the concrete bridge seats and back walls, and for all materials, equipment, tools, labor, and incidentals necessary to complete the item.

DRY RUBBLE MASONRY

Description.—Dry rubble masonry shall be composed of approved stones laid without mortar and so as to fit neatly and firmly, and shall be built in conformity with the plans or as directed by the engineer.

Material.—The stones shall be sound, durable, free from structural defects, and shall be free from rounded, worn, or weathered surfaces, and clean of earth, clay, or other foreign substances. No stone shall be used which has a minimum thickness of less than 5 inches, a minimum width of less than 12 inches, or which is less than ½ cubic foot in volume. In the lower course of a dry rubble wall no stone shall be used which has a volume of less than 1 cubic foot. Small stones may be used for pinning and filling interstices in the heart of the wall.

Method of construction.—All dry rubble masonry shall be constructed by experienced workmen. The stone shall be roughly dressed on beds and joints and laid on natural beds, being well bonded and breaking joints at least 6 inches. Walls need not be built in courses, but shall be so constructed that no part is materially in advance of the other. In all cases the base thickness of dry walls shall be at least half the height, which shall not exceed 8 feet. Headers shall be distributed uniformly throughout the wall, so as to form approximately one-fifth of the exposed faces, and shall extend through the face wall and into the backing at least 12 inches. Where a wall is less than 18 inches in thickness, the headers shall extend entirely through from front to back face. Where the wall is more than 18 inches thick, the headers shall either extend entirely through or overlap at least 6 inches. Walls shall be built up so as to leave no appreciable open spaces, and only sufficient spalls shall be used to wedge the larger stones in place. This class of masonry shall be finished with a top course or coping consisting of roughly shaped stones not less than 6 inches thick, from 1½ to 4 feet long, and wide enough to cover the top of the wall, carefully laid in solid beds.

Basis of payment.—This work will be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the engineer, and will be paid for at the unit price bid per cubic yard for dry rubble masonry complete in place, which price will be full compensation for the coping and for all materials, equipment, tools, labor and incidentals necessary to complete the item.

REINFORCED CONCRETE PIPE

Description.—Under this item reinforced concrete pipe conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as directed.

Material.—Reinforced concrete pipe for culverts shall be of the bell and spigot type, or other type approved by the engineer, with positive connection between sections, but the joints must be as strong as the body of the pipe and all reinforcement must be protected by at least ¾ of an inch of concrete. The pipe shall be cast in sections not less than 3 feet nor more than 8 feet in length.

Portland cement concrete.—Portland cement concrete used in the construction of reinforced concrete pipe shall conform to the requirements for class D concrete. All concrete surfaces shall be reasonably true and even, free from porous or scaly spots, spalled edges, and stone pockets. The sections shall be straight and true to the dimensions shown on the plans and shall have a uniform thickness throughout. Pipes having defective spots patched over shall not be used.

Reinforcement.—Reinforcement shall consist of woven-wire mesh, expanded metal, rods, hoops, spirals, or other forms adopted by the manufacturer and approved by the engineer, and shall extend into the bell of the pipe. All reinforcement shall be manufactured from material that meets the requirements of the standard specifications for billet steel concrete reinforcement bars of the American Society for Testing Materials, serial A15–14.

Dimensions.—The minimum thickness of shell shall conform to the following table·

Inside diameter of pipe	Thickness of shell
Inches	*Inches*
12	2
18	2½
24	2¾
30	3
36	3¼

Load test.—When tested by the three-edge bearing method of applying load in the crushing test as prescribed in United States Department of Agriculture Bulletin No. 1216, the pipe must show no crack under a load of 1,000 D, where D is the inside diameter of the barrel in feet, and shall develop a crushing strength of 1,500 D.

Absorption.—The maximum average absorption as obtained by the absorption test as prescribed in United States Department of Agriculture Bulletin No. 1216, shall not exceed 8 per cent by weight.

Method of measurement and basis of payment.—This item shall be paid for at the contract unit price bid per lineal foot of reinforced concrete pipe of the several sizes, measured complete in place, which price shall be full compensation for furnishing, hauling, and installing the pipe, for preparation of bed and back filling, and for all material, equipment, tools, labor, and incidentals, but shall not be payment for excavation nor for concrete or masonry end walls.

CORRUGATED GALVANIZED METAL PIPE

Description.—Under this item corrugated metal culvert pipe, conforming to these specifications, of the sizes, and dimensions shown on the plans shall be furnished and placed as directed.

Material.—Corrugated metal culvert pipe shall be fabricated from corrugated sheets, the base metal of which shall be made by the open-hearth process. The base metal in the finished sheets shall conform to the following chemical requirements:

The total amount of carbon, phosphorus, sulphur, manganese, and silicon shall not exceed 0.7 per cent. If the total of these five elements equals or exceeds 0.2 per cent, the metal shall

contain not less than 0.17 per cent of copper and not more than 0.06 per cent of sulphur. If the total of these five elements is less than 0.2 per cent, the presence of copper is optional and sulphur shall not exceed 0.04 per cent.

All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

The weight of the culvert sheets, as determined by weighing in lots not exceeding 6,000 pounds, shall not vary from the theoretical weight by more than 5 per cent either way for each lot of one gauge and size.

The base metal sheets shall be uniformly galvanized on both sides by the hot process. A uniform coating of Prime Western spelter shall be applied at the rate of not less than 2 ounces per square foot of metal. If the average spelter coating as determined from samples shows less than 2 ounces of spelter per square foot of metal, or if any one sample shows less than 1.8 ounces of spelter per square foot of metal, the shipment shall be rejected. Sheets having blister spots, holes, or other imperfections in the galvanizing after corrugating shall be rejected.

The tests for weight of spelter coating shall be made as described in the United States Department of Agriculture Bulletin No. 1216.

No metal will be accepted under these specifications and no bids will be considered for the materials above described until after the sheet manufacturer's certified analysis and manufacturer's guarantee have been passed upon by the engineer and accepted.

Misbranding or other misrepresentation and nonuniformity of product will each be considered a sufficient reason to discontinue the acceptance of any brand under these specifications, and the notice of discontinuance of any brand sent to the sheet manufacturer will be considered to be notice to any culvert companies which handle that particular brand.

The brand of metal to be furnished shall be specified in the bid.

The manufacturer of each brand shall file with the engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of each of the five above-mentioned chemical elements. The certificate shall be sworn to for the manufacturing company by a person having legal authority to bind the company.

The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, shall bear a suitable identification brand or mark, and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge, or spelter coating; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

No culverts will be accepted unless the metal is identified by a stamp on each section showing: First, name of sheet manufacturer; second, name of brand; third, the gauge.

The identification brands shall be placed on the sheets by the manufacturers of the sheets, in such a way that when rolled into culverts such identification shall appear on the outside of each section of each pipe. Pipe having any sections not so stamped shall be promptly rejected.

Laboratory tests shall follow the methods of the United States Department of Agriculture Bulletin No. 1216. The analysis made by the chemists or inspection bureau designated or approved by the engineer shall be taken as final, but before any considerable shipment is rejected a check analysis shall be made.

If the engineer so elects, he may have the material inspected at the rolling mill or the culverts inspected in the shop where they are fabricated. He may require a chemical analysis from the mill for any heat, also a physical test of the properties of the metal taken from any heat, to be made by the mill. The inspection both at the mill and at the shop shall be made under the direction of the engineer. The engineer, or his representative, shall have free access to the mill or shop for inspection purposes and every facility shall be extended to him for this purpose. Any material or pipe included in any shipment which has been rejected at the mill or shop will be considered sufficient cause for the rejection of the entire shipment.

Construction of pipe.—Pipe furnished under these specifications shall be of the full circle riveted type, with lap-joint construction.

The length of culvert specified shall be the net length of the finished culvert which does not include any material used to procure an end finish on the pipe. If the average deficiency in length of any shipment of pipe is greater than 1 per cent, the shipment shall be rejected.

All pipe shall be furnished in the lengths ordered, except that pipe for culverts 26 feet or more in length may be furnished in sections not less than 12 feet in length, provided all necessary field couplings are furnished free of charge. For small shipments involving less than carload lots, the above requirements may be modified by written authority from the engineer.

The length of sheets, widths of laps, gauge of the uncoated metal (United States standard gauge), and theoretical weight per lineal foot of the finished culvert shall be as specified in the following table. The dimensions given for diameter of pipe are nominal. The average weight per lineal foot of a finished culvert, exclusive of end fittings, shall not underrun the theoretical weight specified by more than 5 per cent.

Nominal diameter	Length of sheet before forming	Width of lap	Minimum gauge United States standard	Weight per lineal foot of finished culvert
Inches	*Inches*	*Inches*		*Pounds*
12	40	2. 0	16	10. 5
15	50	2. 0	16	13. 1
18	60	2. 5	16	15. 7
21	70	2. 5	14	22. 5
24	80	3. 0	14	25. 8
30	100	3. 5	14	32. 2
36	120	3. 5	12	53. 3

Corrugations shall be not less than 2¼ nor more than 2¾ inches center to center. The corrugations shall have a depth of not less than one-half inch.

Rivets shall have the following dimensions:

No. 16 gauge material (two thicknesses of sheets), $\frac{5}{16}$ by ½ inch.
No. 14 gauge material (two thicknesses of sheets), $\frac{5}{16}$ by ⅝ inch.
No. 14 gauge material (three thicknesses of sheets), $\frac{5}{16}$ by ¾ inch.
No. 12 gauge material (two thicknesses of sheets), ⅜ by ¾ inch.
No. 12 gauge material (three thicknesses of sheets), ⅜ by ⅞ inch.

All rivets shall be driven cold in such a manner that the plates shall be drawn tightly together throughout the entire lap. No rivet shall be closer than twice its diameter to the edge of the metal. All rivets shall have neat, workmanlike, and full hemispherical heads or heads of a form acceptable to the engineer; shall be driven without bending; and must completely fill the hole. Longitudinal seams of 30 and 36 inch pipe shall be double-riveted. Circumferential shop riveted seams shall have a maximum rivet spacing of 6 inches and shall lap at least one full corrugation, except that six rivets will be sufficient in 12-inch pipe.

If a band is used for end finish, it shall be riveted around the end of the culvert with rivets at intervals of 10 inches or less. This band shall be of galvanized metal equivalent in cross section to ⅜ by 1 inch for 16-gauge metal, ⅜ by 1½ inches for 14-gauge metal and 12-gauge metal.

Field joints shall be made with bands of the same material as the culvert, and shall be not less than 7½ inches wide, so constructed as to lap an equal portion of each of the culvert sections to be connected. Such bands shall be connected at the ends by angles having minimum dimensions of 1½ by 1½ by ⅛ inch, and of length equal to full width of band, or by other approved connections of suitable strength. Each connection shall be fastened by at least two bolts not less than ½ inch in diameter. All such connections shall be made of galvanized metal of the same quality as the base metal in the culvert.

It is the essence of these specifications that in addition to compliance with the details of construction the completed pipe shall show careful, finished workmanship in all particulars.

Culvert pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which show defective workmanship, shall be rejected. This requirement applies not only to the individual pipe but to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert pipe or in general in any shipment shall constitute sufficient cause for rejection: Uneven laps; elliptical shaping; variation from a straight center line; ragged or diagonal sheared edges; loose, unevenly lined or spaced rivets; poorly formed rivet heads; unfinished ends; illegible brands; lack of rigidity; bruised, scaled, or broken spelter coating; dents or bends in the metal itself.

The field inspection shall be made by the engineer, who shall be furnished by the contractor with an itemized statement of the sizes and lengths of culvert pipe in each shipment. This inspection shall include an examination of the culvert pipe for deficiencies in length of sheets used, nominal specified diameter, net length of finished culvert pipe, and any evidence of poor workmanship as outlined above. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating. The inspection shall be made promptly upon notification by the contractor of the arrival of the material.

The pipe making up the shipment shall fully meet the requirements of these specifications, and if 50 per cent of the pipe in any shipment fails to meet these requirements the entire shipment may be rejected.

When samples are taken for chemical analysis and determination of weight of spelter coating, at least one sample from which a specimen 2¼ inches square may be prepared shall be selected from each 10 culverts of a shipment, and not less than three samples shall represent any one shipment.

Culverts under the highway shall be placed so that the minimum distance from finished surface of roadbed to the top of pipe shall be not less than one-half the diameter of the pipe with a minimum of 1 foot.

The pipe shall be laid in the trench with the separate sections firmly joined together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in joints which is not thoroughly protected by galvanizing shall be coated with a suitable asphaltum paint.

Method of measurement and basis of payment.—This item shall be paid for at the contract prices bid per lineal foot of corrugated galvanized metal pipe of the several sizes measured complete in place, which price shall be full compensation for furnishing, hauling, and installing the pipe, for preparation of bed and back filling, and for all materials equipment, tools, labor, and incidentals, but shall not be payment for excavation nor for concrete or masonry end walls.

INCIDENTAL CONSTRUCTION

PILING

Requirements for all piling.—Piling shall be designed to sustain the total pressure which may be transmitted to the foundation and piles shall be spaced not closer than 2 feet 6 inches center to center unless they rest on a hard stratum and act as columns. The distance from the side of any pile to the nearest edge of the footing shall not be less than 9 inches. They shall be used only in places where a minimum penetration of 10 feet in firm material, or 20 feet in soft material, can be obtained. For foundations of arch, continuous span, or movable bridges, or high abutments the piles shall be completely embedded in firm earth, sand, or gravel which will afford good lateral support. When this result is impracticable, the soft material shall be excavated from the pit and replaced by heavy riprap, for such distance and depth as the plans indicate or the engineer directs.

All excavation of the foundation in which piles are to be driven shall be complete before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles, leaving a clean, solid surface to receive the concrete.

The contractor shall be responsible for determining the length of piles required, by driving test piles or otherwise.

When subject to transverse forces, batter piles shall be driven in sufficient numbers to resist the transverse forces without assistance from the vertical piles.

When called for on the plans, piling shall be inclosed by permanent water-tight sheet piling, the top of which shall be sawed off about 1 foot below low water.

If tests are called for on the plans or in the special provisions, the contractor shall submit a price per test for testing piles, the number of tests to be determined by the engineer. Tests shall be made by loading the pile to two times the working load without exceeding a permanent settlement of one-quarter inch in 48 hours unless otherwise specified. In case the safe carrying capacity of any pile is found by test, or by formula if not tested, to be less than the load that it was intended to carry, additional piles shall be driven until the load per pile to be borne is reduced to safe carrying capacity.

UNTREATED TIMBER PILING

Description.—Piling shall consist of round or square timber of the kind and dimensions specified, driven in the location and to the elevations shown on the plans or as directed, and in conformity with these specifications.

Material for foundation piles.—These piles may be of any species which will satisfactorily stand driving. They shall be cut from live, sound trees, shall be solid and free from defects such as injurious ring shakes, large unsound or loose knots, decay, or other defects which might impair their strength or durability. They shall be cut above the ground swell and have a uniform taper and shall be free from short bends. A straight line drawn from the center of the butt to the center of the tip shall lie wholly within the body of the pile. Piles shall be peeled soon after cutting. All knots shall be trimmed close to the body of the pile. For round piles the minimum diameter at the tip shall be 8 inches, and at the butt shall be 12 inches. The maximum diameter at the butt shall be 20 inches. Square piles shall be uniform in cross section, not less then 10 by 10 inches for lengths up to 30 feet, nor less than 12 by 12 inches for lengths over 30 feet.

If possible, piles shall be full length. Where the length required is greater than is practical to obtain, they may, upon written approval of the engineer, be spliced. All splices shall be made in accordance with detail plans prepared to meet the special conditions encountered and which shall be approved before the piles are driven.

Material for trestle piles and foundation piles for trestle bents.—These piles shall meet the requirements for timber foundation piles and in addition shall be of durable timber. The species required will be given on the plans or in the special provisions.

Construction methods.—The tops of foundation piles shall be embedded in the concrete footing at least 1 foot, and where seals of concrete deposited in water are used with piles, the piles shall project at least 6 inches above the top of the seal concrete. They shall be cut off level at such an elevation that the tops of the piles will be always wet.

Foundation piles for framed bents shall be cut off level approximately 3 feet above the surface of the ground and the cap ridgidly secured to each pile by drift bolts extending at least 9 inches into the pile.

Trestle piles shall be cut off level at the elevation shown on the plans and the caps secured as described above. If the cut-off is 10 feet or more above the ground line, timber piles shall be braced by diagonal cross bracing secured to the piles by ¾-inch diameter through bolts.

In bents of untreated piles the heads of the piles shall be thoroughly coated with a thick protective coat of red-lead paint before the caps are placed.

The load per pile for foundation piles shall generally not exceed 15 tons, with a maximum limit of 20 tons. The load per pile for trestle piles and for foundation piles for trestle bents shall generally not exceed 10 tons, with a maximum limit of 12 tons.

Driving.—Timber piles shall be provided with a metal collar when necessary to prevent splitting in driving. Metal shoes of an approved design shall also be used when ordered by the engineer. Piles shall be driven strictly in accordance with the lines and spacing shown on plans, and not more than ¼ inch variation per foot of length will be permitted. They shall be driven until their safe carrying capacity as determined by the following formulae is not less than 20 tons:

For gravity hammers, $P=\frac{2WH}{S+1}$

For steam hammers, $P=\frac{2WH}{S+0.1}$

Where P = safe load per pile in pounds,
W = weight of falling hammer in pounds,
H = height of fall in feet,
S = the average penetration per blow in inches for the last 5 blows of a gravity hammer or the last 20 blows of a steam hammer.

In case the above carrying capacity can not be obtained, plans showing the necessary modification of the design of the footings and the number and location of the piles required shall be furnished by the engineer.

Jetted piles.—Jetted piles shall extend to a good solid stratum. Their carrying capacity shall be determined by actual tests or by the same method and formula as in the case of unjetted piles, provided that no jet be used during the test blows.

Basis of payment.—Untreated timber piling will be paid for as specified under concrete piling.

TREATED TIMBER PILING

Description.—Treated piling shall consist of round or square timbers of the kind and dimensions shown on plans, treated as noted on the plans and specified below, driven in the location and to the elevations shown on plans or as directed in conformity with these specifications.

Material requirements for treated foundation piles, treated trestle piles, and treated foundation piles for trestle bents, shall be identical with the corresponding requirements for untreated timber piling, with the additional requirements following:

Piles shall be treated with the creosote oil or creosote coal tar solution described in the specifications for timber structures.

The ranges of pressure, temperature, and time duration of treatment shall be controlled so as to result in maximum penetration of the quantity of preservative injected, which shall permeate all of the sapwood and as much of the heartwood as practicable.

For general construction, not in sea water, piles shall be treated to retain not less than 12 pounds of the preservative per cubic foot of wood by any full-cell process, or not less than 8 pounds by any standard empty-cell process.

Piles for use in water liable to be infected by marine borers along the Pacific coast shall be treated to retain not less than 16 pounds of Grade 1 creosote oil by any standard full-cell process for all kinds of timber except Douglas fir. Douglas fir shall be treated to retain not less than 12 pounds of Grade 1 creosote oil by any standard full-cell process. Timber for other uses in these waters shall be treated by a full-cell process so as to have full penetration of all sapwood and as much of the heartwood as practicable and to retain not less than 12 pounds of Grade 1 creosote oil, except Douglas fir, which shall be treated to retain not less than 10 pounds by any standard full-cell process.

Construction methods for treated timber piling shall be identical with those prescribed for untreated timber piling, except that the heads of piles need not be coated with protective paint. The following additional requirements apply to treated timber piling:

Treated piles and timbers shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. They shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

All places where the surface of treated piles or timbers is broken by cutting, boring, or otherwise, shall be thoroughly coated with hot creosote oil and then with a coating of hot tar pitch. Hot creosote oil shall be poured into the bolt holes before the insertion of the bolts in such manner that the entire surface of the holes shall receive a coating of the oil.

After the necessary cutting has been done to receive the cap, the heads of treated piles shall be given three coats of hot creosote oil. They shall then be covered with a coat of hot tar pitch, over which shall be placed a sheet of three-ply roofing felt or galvanized iron, or a covering may be built up of alternate layers of hot tar pitch and loose-woven fabric similar to membrane waterproofing, using four layers of pitch and three of the fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large-headed nails or secured by binding with galvanized wire.

Basis of payment.—Treated timber piling will be paid for as specified under concrete piling.

CONCRETE PILING

Description.—Concrete piles shall be made in accordance with these specifications and the designs shown on the plans or, if not shown on the plans, designs shall be submitted for approval. They shall be placed in accordance with these specifications in the location and to the elevation shown on the plans or as directed by the engineer.

Material.—All concrete materials and their preparation and placing shall be in accordance with the requirements for class D concrete, except that concrete for piles shall be composed of 1 part Portland cement, 1½ parts fine aggregate, and 3 parts coarse aggregate. The maximum size of the coarse aggregate shall be 1 inch.

Reinforcement shall conform to the requirements for reinforcing steel of these specifications, and the weight and dimensions shall be as shown on plans.

Where waterproofing is to be used, special specifications will be given and the work shall be in accordance therewith.

The average diameter shall not be less than 12 inches, and the diameter at the point not less than 8 inches. The length shall not exceed 30 times the average diameter for piles driven through firm soil, and shall not exceed 15 times the average diameter for piles driven to rock through loose, wet soil or filled ground. When lateral support is deficient, so that the piles act as columns, they shall be designed as columns.

Concrete piles when properly designed, constructed, and placed may be subjected to loads as determined by tests or formula, but not to exceed 300 pounds per square inch of total cross section at the smallest effective point and generally not to exceed 25 tons per pile, with a maximum limit of 30 tons per pile.

Method of construction.—Precast piles shall be made in accordance with the plans, and reinforcement shall be accurately placed and rigidly secured in such manner as to insure its proper location in the completed pile. Special reinforcement at the top and bottom to protect them from damage in driving shall be provided. The centers of the main reinforcing bars shall be not closer to the surface of the concrete than 2½ inches. The concrete shall be carefully placed, tamped, and spaded, care being taken to fill every part of the form and to work the concrete around and under the reinforcement without displacing it. The piles shall be cast separately, or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until four days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed. The concrete shall be placed continuously in each pile. The completed piles must be free from stone pockets, porous spots, or other defects, and be straight and true to the form specified. The forms shall be true to line, built of dressed lumber, and a 1-inch chamfer strip shall be used in all corners; they shall be water-tight and shall not be removed within 24 hours after the concrete is placed. All exposed surfaces of the pile shall be given a rubbed finish. The piles shall be cured at least 40 days at a temperature of not less than 40° F., or 30 days at a tempera-

ture of not less than 60° F. Piles shall be at least 30 days old when driven. When concrete piles are lifted or moved they shall be supported at the quarter points and they shall be so designed that the unit stresses produced by handling, as described above, will not exceed 650 pounds per square inch compression in concrete nor 16,000 pounds per square inch tension in steel.

Driving.—Requirements for driving large concrete piles will be covered by special qualifications. Under usual conditions; that is, piles containing not over 2 cubic yards of concrete, they shall be driven with drop hammers weighing not less than the pile, or with double-acting steam hammers, the total weight of which is not less than two-thirds the weight of the pile. In driving, the tops of the piles shall be protected by suitable cushions of wood, rope, or other material so placed as to reduce the injury to the pile to a minimum. Metal shoes or points of an approved design shall be used when ordered by the engineer. Concrete piles shall be driven until their safe carrying capacity, as determined by the following formula, is not less than 30 tons:

For gravity hammers, $P = \frac{2WH}{S+1}$

For steam hammers, $P = \frac{2WH}{S+0.1}$

Where P = safe load per pile in pounds,
W = weight of falling hammer in pounds,
H = height of fall in feet,
S = the average penetration in inches per blow for the last 5 blows of a gravity hammer or the last 20 blows of a steam hammer.

In case the above carrying capacity can not be obtained, plans showing the necessary modification of the design of the footings and the number and location of the piles required shall be furnished by the engineer.

Jetted piles shall extend to a good solid stratum. Their carrying capacity shall be determined by actual tests or by the same method and formula as in the case of unjetted piles, provided that no jet be used during the test blows. Jet pipes shall not be embedded in the piles.

Piles cast in place.—When piles are cast in strong metal shells which have been driven in accordance with the specifications for driving concrete piles and which remain in place after the concrete has set, the safe loads for piles completely embedded in firm earth may be taken the same as specified under "material." Piles cast in place without metal reinforcement shall not be used in water or in ground so soft, in either wet or dry condition, as not to give firm lateral support. No pile of this type shall be concreted until all driving within a radius of 6 feet has been completed, and care shall be taken that the piles are in no way disturbed until the concrete has become hard.

Basis of payment.—All piling will be paid for at the contract unit price bid per lineal foot for untreated timber piling, treated timber piling, or concrete piling, as the case may be, complete in place, which price shall include all materials, equipment, tools, labor, and incidentals thereto. Payment will be made for only the actual number of feet of piles left in place in the completed work, and no allowance will be made for any piles which are not driven in accordance with the specifications, or as ordered by and made acceptable to the engineer.

Metal driving points, when ordered, will be furnished by the Government, unless otherwise specified, but the price per lineal foot of pile shall include all expense incidental to their use, including hauling from the designated point of delivery. Heavy riprap for lateral support in soft material or sheet piling, if required, shall be paid for under a supplemental agreement or as force account.

HAND-LAID RIPRAP

Description.—Where necessary, slopes shall be protected by hand-laid riprap, which shall be constructed at the places indicated, and of the shape and thickness shown on the plans or directed by the engineer.

Material.—The stone for this work shall be sound, durable, one-man stone not less than 3 inches thick nor containing less than one-half of a cubic foot in volume. No stone shall be used that does not extend through the revetment.

Method of construction.—The slopes protected shall not be steeper than the angle of repose of the material unless otherwise indicated. The stones shall be placed with their beds at right angles to the slope, the larger stones being used in the bottom courses and the smaller stones at the top. They shall be laid in close contact so as to break joints, and in such manner that the weight of the stone is carried by the earth and not by the adjacent stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The finished work shall present an even, tight, and reasonably plain surface, varying not more than 3 inches from the required contour.

Basis of payment.—This work will be paid for at the unit price bid per cubic yard for hand-laid riprap, complete in place, which price will include all necessary excavation, back filling, materials, equipment, tools, labor, and incidentals necessary to complete the item.

HAND-LAID ROCK EMBANKMENT

Description.—Where necessary, slopes shall be steepened on embankments and the embankments strengthened by the use of hand-laid rock which shall be constructed according to the lines and dimensions given by the engineer before work is started.

Material.—The stones for this work shall be sound and durable, not less than one-half cubic foot in volume, and may be taken from the adjacent excavation.

Method of construction.—An adequate footing shall first be excavated in stable ground along the toe of the slope of the proposed fill. The selected stone material shall be placed by hand on this prepared footing and additional stone laid up to the width and dimensions directed. Care shall be taken to have the stones bonded to some extent and securely bedded. Spalls shall be used to fill voids. The hand-laid rock embankment thus constructed shall be backed by the usual embankment placed as prescribed under earthwork.

Method of measurement.—Hand-laid rock embankment shall be measured when complete in place as ordered. The excavation for the footing prescribed shall not be measured. When stone material for this item is obtained from roadway or other prescribed excavation, no deduction from the excavation yardage for the stone so used shall be made.

Basis of payment.—This item shall be paid for at the unit price bid per cubic yard for hand-laid rock embankment complete in place, which price shall be full payment for selecting and placing by hand the material measured, and for all footing excavation, equipment, tools, labor, and incidentals necessary to complete the item.

UNDERDRAINS

Description.—At such places as are shown on the plans or as are designated by the engineer, underdrains shall be constructed. They shall have suitable outlets in culverts, or such other outlets as to drain water entirely away from the road and protect the outlet of the drain. They shall be constructed directly under the gutter or ditch or under the roadway to the line and grade furnished by the engineer and in accordance with the plans and these specifications.

Material and method of construction.—*Vitrified tile underdrain.*—The trench shall be excavated with a bottom width of 12 inches to the line and grade given by the engineer, the depth of trench to vary from 2½ to 3½ feet below the finished surface at the top of the trench. A 2-inch bed of clean gravel or broken stone, all passing a 1-inch screen, shall be spread in the bottom of the trench throughout its entire length and brought to a uniform grade. Salt-glazed, bell and spigot, vitrified drainpipe of the size specified shall be bedded firmly in the bottom course of stone, with the bell end upgrade and the spigot end fully entered in the adjacent bell. The pipe joints shall then be covered with 2-ply tar-paper strips not less than 6 inches in width and

of sufficient length to permit the ends being turned outward and laid flat on the bottom course of stone on either side of the pipe for a distance of 3 inches.

After the pipe has been laid and approved by the engineer, clean gravel or broken stone filling, all passing a 3½-inch screen and retained on a ¾-inch screen, shall be placed carefully so as not to displace the pipe or joint covering, around and over the pipe to a depth of at least 12 inches above the top of the pipe. The remainder of the trench shall be filled with selected earth material from excavation. Both stone and surface filling shall be firmly tamped.

Porous tile underdrain.—Porous tile underdrain shall be laid in the same manner as specified for vitrified tile underdrain. The tile shall be of specified diameter, of ½-inch thickness, and of uniformly burned clay acceptable to the engineer.

Blind drain.—Where blind drains are called for, they shall be dug to the cross section shown on the plans and from 30 to 40 inches in depth, depending on the nature and condition of the soil to be drained. The trench thus prepared shall be filled with clean, broken stone or gravel, from 1 to 3½ inches in size, well compacted to within 12 inches of the gutter surface. The upper 12 inches of the trench shall then be filled with suitable earth material. Both stone and surface filling shall be firmly tamped to avoid future settlement.

Method of measurement and basis of payment.—This item shall be paid for at the contract unit price bid per lineal foot of vitrified tile underdrain, porous tile underdrain, or blind underdrain, as the case may be, measured complete in place, which price shall be full payment for furnishing and installing pipe and material, all excavation, back filling, equipment, tools, labor, and incidentals necessary to complete the item.

WOOD GUARDRAIL

Description.—Single-rail guardrail of either rustic, rough-sawed, or surfaced and painted timber shall be constructed where called for on the plans or directed by the engineer, and shall conform in all respects to the requirements of the plans or the special provisions.

Material.—The posts and railing shall be of the species of timber specified on the plans or, if not specified thereon, as required by the engineer.

Round or rustic posts shall be straight, sound, and free from defects of all kinds, and shall be cut from live trees not less than 30 days in advance of use, but not exceeding one year, and be allowed to season with the bark on. Immediately before use in the work, all bark shall be peeled and the logs trimmed smooth of all knots and projections.

Sawed posts and rails shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given. Sawed railing shall be of sufficient length to span two panels, except on curves. It shall be surfaced four sides, and the dimensions indicated shall be construed to mean the nearest commercial size.

White paint shall consist of 3 parts by weight of white lead to 1 part by weight of zinc oxide, uniformly combined and mixed with pure linseed oil to the required consistency for priming or for second and third coat. Turpentine drier may be added to the paint but shall not exceed an average proportion of ½ pint of drier to 1 gallon of paint. The white lead and zinc oxide shall be of a reputable and approved brand, ground in oil, and shall be delivered separately on the project in the original containers before being opened or mixed with the linseed oil.

Black paint shall consist of lampblack ground in oil and mixed to the required consistency with pure raw linseed oil.

Method of construction.—Posts, except rustic posts, shall first be treated with an approved preservative bituminous paint or other approved preservative at their butt or lower ends as shown on the plans to a point 8 inches above the ground line. The posts shall be set vertically to the depth shown on the plans. They shall be maintained in accurate alignment while the post holes are back filled with suitable material and thoroughly tamped in layers. After back filling, the posts shall be sawed to exact grade and sloped or beveled as called for on the plans.

Posts and railings shall be so shaped or notched that satisfactory contact surfaces will be obtained where rails are secured to the posts. All rails shall be squarely butt-jointed at posts.

Sawed and surfaced guardrail shall be painted with three coats of approved white paint as hereinbefore specified above a point 8 inches above the ground line. All timber to be painted must be seasoned and painting shall be done only when the timber is free from frost and the surface is perfectly dry and clean. No painting shall be done in wet or freezing weather. All paint shall be thoroughly dry before applying the succeeding coats. It shall be applied in good heavy coats, completely covering every part of the surface, and shall be well worked into the joints and open spaces; it shall be so thoroughly and evenly spread that no excessive paint will collect at any point.

Method of measurement and basis of payment.—This item will be paid for at the price bid per linear foot of wood guardrail complete in place, measured from outside to outside of end posts; the price bid shall be full payment for all posts and rails, all materials, including nails, bolts, driftbolts, paint, all excavation and back filling, all equipment, tools, labor, and incidentals. Standing timber for round posts and rustic rails, when so noted on plans, will be available for cutting under the same conditions stipulated for standing timber for log bridges. Payment for handrail on bridges will be included in the price bid for bridge superstructures.

WIRE CABLE GUARDRAIL

Description.—This item shall consist of two lines of wire cable supported on wood posts and constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the engineer, and in conformity with the details and dimensions shown on the plans.

Materials.—All cable shall be manufactured of double-galvanized annealed steel having the properties hereinafter required. The wire shall be cylindrical in form and be free from scales, inequalities, flaws and splits.

Each wire of the cable shall be galvanized by the hot dip method and shall have a continuous coating of pure zinc of a uniform thickness, so applied that it will adhere firmly to the surface of the wire, and it shall be capable of withstanding four immersions in a standard testing solution of copper sulphate without showing any trace of metallic copper on the steel. The first three immersions shall be for a period of one minute each and the fourth immersion for a period of one-half minute.

Three-quarter inch cable.—The cable shall be composed of 3 strands, each strand having 7 wires. The diameter of the finished cable shall not be less than ¾ inch. The wire composing the cable shall be of such quality that the finished cable shall satisfy all the requirements hereinafter set forth. All the wires in the cable shall be of the same grade of steel and shall have approximately the same breaking strain.

The lay of the finished cable shall not be more than 7½ inches. The lay of the wires in the strand shall not be more than 4½ inches. The diameter of the finished wires entering into the cable shall not be less than 0.117 inch and not more than 0.124 inch. The minimum tensile strength of the cable shall be 13,000 pounds.

All wire cable must be shipped upon substantial wooden reels. Each reel shall have the length and weight of the cable plainly and indelibly marked on a strong tag, firmly attached. The wooden reel shall be mounted so that it will revolve, and the cable run off by pulling straight ahead. Precaution must be taken by the contractor in handling the wire cable to prevent the displacement of the galvanizing.

The posts shall be as required for wood guardrail, treated and painted as required herein, and shall conform to the dimensions shown on the plans.

Anchors for all end posts shall consist of a concrete "dead man" and necessary fittings of the design, dimensions, and details shown on the plans. All metal fittings are to be galvanized.

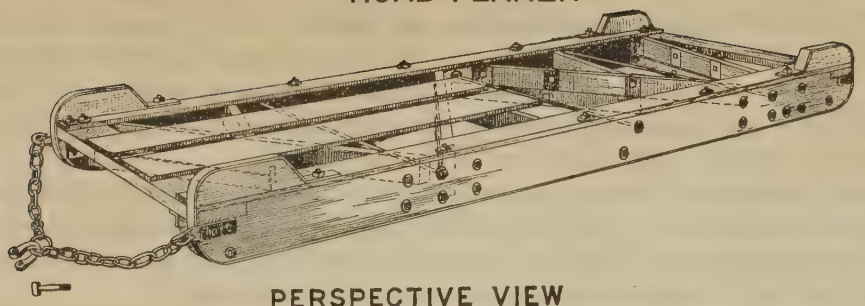
Construction methods.—The posts shall be set plumb and firm, spaced 10 feet apart on center, at least 3½ feet in the ground, and to lines and grades given. Posts shall be located from 3½ to 4 feet from the nearest edge of pavement to the near face of post, unless otherwise directed by the engineer. There shall be a 1-inch chamfer around the top of each post. The wire cable shall pass through hook bolts or other fastenings as shown on the plans, and shall be drawn taut and fastened securly on both ends, as shown.

After erection is completed, the posts and all parts not galvanized shall be painted with three coats of paint of the specified material and quality, which shall be brushed in thoroughly.

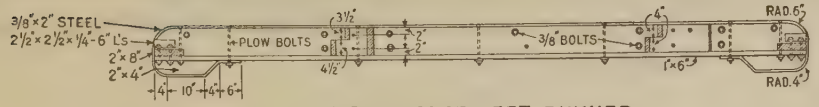
Method of measurement.—The measurement shall be from outer post to outer post, and shall not include the distance from the end posts to "dead man."

Basis of payment.—This item shall be paid for at the contract unit price per linear foot for wire cable guardrail complete in place, which price shall be full compensation for furnishing all wire cable, posts, and fittings; for all preparation and erection of same, all labor, equipment, tools, and incidentals necessary to complete the work.

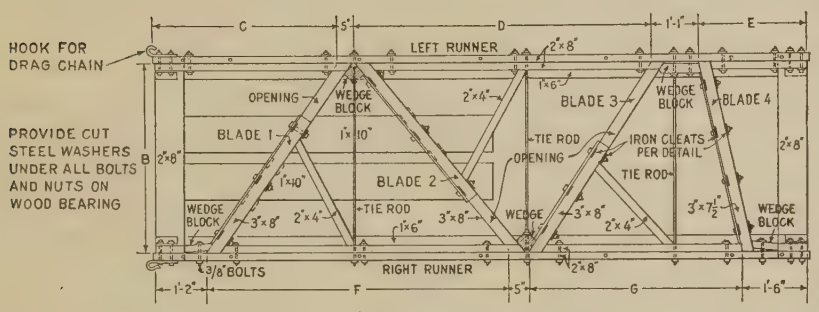
ROAD PLANER



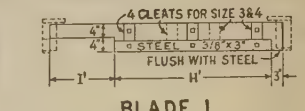
PERSPECTIVE VIEW



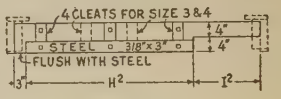
INSIDE FACE LEFT RUNNER



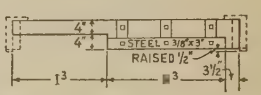
PLAN OF UNDERSIDE



BLADE 1

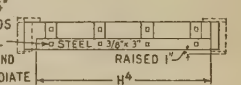


BLADE 2



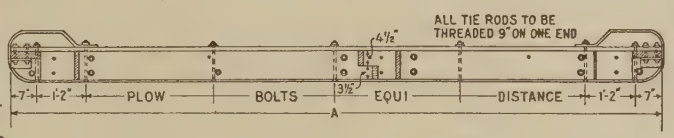
BLADE 3

ALL BOLTS UNIFORMLY SPACED 4" FROM ENDS OF STEEL BLADES AND INTERMEDIATE BOLTS EQUI-DISTANT BETWEEN

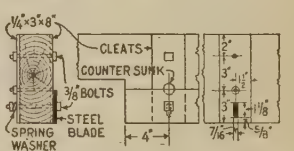


BLADE 4

RUNNERS CONSTRUCTED OF 2 PIECES 2"×8", SPIKED AND BOLTED. INSIDE PIECE CUT FOR BLADES AS SHOWN. BLADES TO BE ADJUSTABLE VERTICALLY AND HELD TO RUNNERS BY BOLTED WEDGE BLOCKS.



INSIDE FACE RIGHT RUNNER



CLEATS AND WOOD BLADES ARE SLOTTED FOR ADJUSTING, LOWERING, REVERSING, AND REMOVING WORN STEEL BLADES. CLEATS ON CUTTING SIDE OF BLADE ARE REBATED FLUSH WITH FACE OF WOOD BLADE

DETAILS OF IRON CLEATS

IMPORTANT NOTE:-
NO DEVIATIONS FROM DESIGN ARE PERMITTED, TO ALLOW READY REPLACEMENT OF WORN OR BROKEN PARTS FROM STOCK

DETAIL PLANS

Size	Length	Width	Runners					Blades							Tie rods	Project: —, No. —
								Steel				Opening				
	A	B	C	D	E	F	G	H^1	H^2	H^3	H^4	I^1	I^2	I^3		Road planer size specified
1	15′ 0″	4′ 4″	4′ 2″	6′ 10″	2′ 6″	7′ 0″	4′ 11″	3′ 5″	4′ 0″	3′ 5″	4′ 0″	1′ 7¼″	1′ 4½″	1′ 5½″	½″ x 57½″	
2	16′ 7″	5′ 0″	4′ 7″	7′ 10″	2′ 8″	8′ 0″	5′ 6″	4′ 0″	4′ 7″	4′ 0″	4′ 7″	1′ 9¾″	1′ 8″	1′ 8″	½″ x 65½″	
3	18′ 3″	5′ 8″	5′ 1″	8′ 10″	2′ 10″	9′ 0″	6′ 2″	4′ 7″	5′ 2″	4′ 7″	5′ 2″	2′ 0¾″	1′ 11″	1′ 11″	⅝″ x 73½″	
4	19′ 11″	6′ 4″	5′ 7″	9′ 10″	3′ 0″	10′ 1″	6′ 9″	5′ 2″	6′ 0″	5′ 2″	6′ 0″	2′ 3¾″	2′ 1¾″	2′ 1½″	⅝″ x 81½″	

INDEX

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FORM F. R. 50-A

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

DISTRICT No._____

BID, CONTRACT, AND BONDS FOR FOREST ROAD CONSTRUCTION

REVISED 1927

PROJECT_____

STATE OF_____

PROJECT NUMBER _____

This form is to be used with, and as a component part of
Bureau of Public Roads Form F. R. 50
Revised 1927

WASHINGTON
GOVERNMENT PRINTING OFFICE
1927

NAME OF ROAD_____

BEGINNING AT_____

ENDING AT_____

NATIONAL FOREST_____

COUNTY_____

LENGTH IN MILES_____

TYPE OF IMPROVEMENT_____

_____

_____

_____

Standard Form No. 20
Approved by the President
Nov. 19, 1926

STANDARD GOVERNMENT FORM OF INVITATION FOR BIDS

(CONSTRUCTION CONTRACT)

(Department)

(*Place*) ---

(*Date*) ---

SEALED BIDS, in {duplicate / triplicate} subject to the conditions contained herein, will be received until , 19 , and then publicly opened, for furnishing all labor and materials and performing all work for

10—1769

Where copies of plans are requested, a deposit of $ will be required to insure their return.

Guarantee will be required with each bid as follows:
(See paragraph 8 of Instructions to Bidders)

Performance bond will be required as follows:

Liquidated damages for delay will be

Partial payments { will / will not } be made
(See Article 16 of contract)

Article on patents { will / will not } be made a part of the contract.
(See directions on back of contract)

Bids must be submitted upon the Standard Government Form of Bid and the successful bidder will be required to execute the Standard Government Form of Contract for Construction.

The right is reserved, as the interest of the Government may require, to reject any and all bids, to waive any informality in bids received, and to accept or reject any items of any bid, unless such bid is qualified by specific limitation.

Envelopes containing bids must be sealed, marked, and addressed as follows:

Bid for ---------- ----------

To be opened ---------- ----------

NOTE.—See Standard Government Instructions to Bidders and copy of the Standard Government Form of Contract, Bid Bond, and Performance Bond, which may be obtained upon application.

GOVERNMENT PRINTING OFFICE 10—1769

Standard Form No. 21
Approved by the President
Nov. 19, 1926

STANDARD GOVERNMENT FORM OF BID

(CONSTRUCTION CONTRACT)

(*Place*) .....

(*Date*) .....

To .....

.....

In compliance with your invitation for bids dated
and subject to all the conditions thereof, the undersigned

a corporation organized and existing under the laws of the State of
a partnership consisting of

or an individual trading as

of the city of
hereby proposes to furnish all labor and materials and perform all work required for

in strict accordance with the specifications, schedules, and drawings,

for the consideration of

10—1770

The undersigned agrees, upon receipt of written notice of the acceptance of this bid within days (60 days if no shorter period be specified) after the date of opening of the bids, to execute the standard form of Government contract, in accordance with the bid as accepted, and give bond, with good and sufficient surety, or sureties, for the faithful performance of the contract, within 10 days after the prescribed forms are presented for signature.

Performance will begin within calendar days after date of receipt of notice to proceed and will be completed within calendar days from that date.

By ---

(Business address)

NOTE.—Read Standard Government Instructions to Bidders before preparing this bid.

10—1770 GOVERNMENT PRINTING OFFICE

Standard Form No. 22
Approved by the President
Nov. 19, 1926

STANDARD GOVERNMENT INSTRUCTIONS TO BIDDERS

(CONSTRUCTION AND SUPPLIES)

1. **Preparation of bids.**—Unless otherwise directed in the invitation, bids shall be submitted in triplicate. Forms furnished, or copies thereof, shall be used, and strict compliance is necessary with the requirements of the invitation, these instructions, and the instructions printed on the forms. Special care should be exercised in the preparation of bids. Bidders must make their own estimates of the facilities and difficulties attending the execution of the proposed contract, including local conditions, uncertainty of weather, and all other contingencies. All designations and prices shall be fully and clearly set forth. Copies of the bids shall be identical. The proper blank spaces in the bid and guaranty forms shall be suitably filled in.

2. **Labor and material not to be furnished by the Government.**—The Government will not furnish any labor, material, or supplies unless specifically provided for in the contract.

3. **Signature to bids.**—Each bid must give the full business address of the bidder and be signed by him with his usual signature. Bids by partnerships must be signed with the partnership name by one of the members of the partnership or by an authorized representative, followed by the signature and designation of the person signing. Bids by corporations must be signed with the name of the corporation, followed by the signature and designation of the president, secretary, or other person authorized to bind it in the matter. The names of all persons signing shall also be typed or printed below the signature. A bid by a person who affixes to his signature the word "president," "secretary," "agent," or other designation, without disclosing his principal, may be held to be the bid of the individual signing. When requested by the Government, satisfactory evidence of the authority of the officer signing in behalf of the corporation shall be furnished.

4. **Bids for all or part.**—Where bids are not qualified by specific limitations, the Government reserves the right of awarding all or any of the items according to its best interests. Unless otherwise required in the specifications, bids for supplies shall be submitted in accordance with the numbered item or items given in the schedule.

5. **Alternative bids.**—Alternative bids will not be considered unless called for.

6. **Specifications and schedules.**—The specifications, schedules, and drawings which form the basis of any bid will be considered as a part thereof and will form a part of the contract. Copies of these papers, together with a copy of the standard contract form, including authorized additions or deletions, if any, will be furnished to or made available for the inspection of bidders by the office indicated in the advertisement or invitation.

7. **Corrections.**—Erasures or other changes in the bids must be explained or noted over the signature of the bidder.

8. **Guaranty.**—Where security is required to insure the execution of contract and bond for performance of the service, no bid will be considered unless it is so guaranteed. The bidder, at his option, may furnish a guaranty bond, a certified check, or deposit, in accordance with Treasury Department regulations, United States bonds (at par value) as security in the amount required: *Provided*, That where not in conflict with the law, the bidder may be limited to the option of furnishing a certified check or United States bonds when the amount of the security does not exceed $1,000, notice of such requirement to be given in the invitation to bidders.

In case security is in the form of a certified check or United States bond, the Government may make such disposition of the same as will accomplish the purpose for which submitted. Certified checks may be held uncollected at the bidder's risk. Certified checks, or the amount thereof, and United States bonds of unsuccessful bidders will be returned as soon as practicable after the opening.

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9. **Sufficiency of guarantors and sureties.**—The bond of any surety company authorized by the Secretary of the Treasury to do business, or of two responsible individual sureties, will be accepted as security for any bid or contract. Individual guarantors or sureties must make the affidavit appearing on the bond as to their sufficiency and furnish the certificate of a judge or clerk of a court of record, a United States district attorney or commissioner, or the president or cashier of a bank or trust company. Individual sureties shall justify in sums aggregating not less than double the penalty of the bond.

10. **Restrictions as to guarantors and sureties.**—A firm, as such, will not be accepted as a guarantor or surety, nor a partner for copartners or for a firm of which he is a member. Stockholders of a corporation may be accepted as guarantors or sureties provided their qualifications as such are not dependent upon their stock holdings therein. Guarantors and sureties, if individuals, must be citizens of the United States, except that sureties on bonds executed in any foreign country, the Canal Zone, the Philippine Islands, Porto Rico, Hawaii, Alaska, or any possession of the United States, for the performance of contracts entered into in these places, need not be citizens of the United States, but if not citizens of the United States must be domiciled in the place where the contract is to be performed.

11. **Seals on bonds.**—When the principal, a guarantor, or a surety is an individual, his signature to a guaranty or bond shall have affixed to it an adhesive or scroll seal. If executed in Maine, Massachusetts, or New Hampshire, an adhesive seal is required. Corporate seals shall be affixed by corporations, whether principals or sureties.

12. **Marking and mailing bids.**—Bids, with their guaranties, must be securely sealed in suitable envelopes, addressed and marked on the outside as required by the invitation.

13. **Time for receiving bids.**—Bids received prior to the time of opening will be securely kept, unopened. The officer whose duty it is to open them will decide when the specified time has arrived, and no bid received thereafter will be considered, except that when a bid arrives by mail after the time fixed for opening, but before award is made, and it is shown to the satisfaction of the officer authorized to make the award that the nonarrival on time was due solely to delay in the mails for which the bidder was not responsible, such bid will be received and considered. No responsibility will attach to an officer for the premature opening of a bid not properly addressed and identified. Unless specifically authorized, telegraphic bids will not be considered, but modifications by telegraph of bids already submitted will be considered if received prior to the hour set for opening.

14. **Withdrawal of bids.**—Bids may be withdrawn on written or telegraphic request received from bidders prior to the time fixed for opening. Negligence on the part of the bidder in preparing the bid confers no right for the withdrawal of the bid after it has been opened.

15. **Bidders present.**—At the time fixed for the opening of bids, their contents will be made public for the information of bidders and others properly interested, who may be present either in person or by representative.

16. **Award or rejection of bids.**—The contract will be awarded to the lowest responsible bidder complying with conditions of the invitation for bids, provided his bid is reasonable and it is to the interest of the United States to accept it. The bidder to whom the award is made will be notified at the earliest possible date. The United States, however, reserves the right to reject any and all bids and to waive any informality in bids received whenever such rejection or waiver is in the interest of the United States. It also reserves the right to reject the bid of a bidder who has previously failed to perform properly or complete on time contracts of a similar nature, or a bid of a bidder who is not in a position to perform the contract.

17. **Time of performance.**—When not otherwise specified in the invitation, the bidder must state the least number of calendar days (counting Sundays and holidays) after date of receipt of notice to proceed, in which he will commence performance, and the number of calendar days (counting Sundays and holidays) thereafter in which he will complete. In stating time the bidder should make due allowance for probable difficulties which may be encountered. 10—1772

18. **Bidders interested in more than one bid.**—If more than one bid be offered by any one party, by or in the name of his or their clerk, partner, or other person, all such bids may be rejected. (Sec. 3722, R. S.) This shall not prevent a bidder from proceeding under paragraph 5 hereof, nor from quoting different prices on different qualities of material or different conditions of delivery. A party who has quoted prices on materials to a bidder is not thereby disqualified from quoting prices to other bidders or from submitting a bid directly for the materials or work.

19. **Errors in bid.**—Bidders or their authorized agents are expected to examine the maps, drawings, specifications, circulars, schedule, and all other instructions pertaining to the work, which will be open to their inspection. Failure to do so will be at the bidder's own risk, and he can not secure relief on the plea of error in the bid. In case of error in the extension of prices the unit price will govern.

20. **Preference for domestic articles.**—Preference will be given to articles or materials of domestic production, conditions of quality and price, including duty, being equal.

21. **Dealer or manufacturer.**—In bids for supplies or manufactured articles, bidders will state whether they are manufacturers of or regular dealers in the articles. If practicable to do so, bidders who are not manufacturers will give the name of the manufacturer from whom the articles are to be obtained, including catalogue references.

22. **Samples.**—When samples are required, they must be submitted by the bidder so as to reach the office designated prior to the hour set for opening the bids. Samples shall be furnished free of expense to the Government, properly marked for identification, and accompanied by a list when there is more than one sample. The Government reserves the right to mutilate or destroy any sample submitted whenever it may be considered necessary to do so for the purpose of testing. Samples not required in connection with the award or delivery of supplies will, upon request, if promptly made, be returned at the bidder's expense.

23. **Contract and bond.**—The bidder to whom award is made must, when required, enter into written contract on the standard Government form, with satisfactory security in the amount required, within the period specified or, if no period be specified, within ten days after the prescribed forms are presented to him for signature.

24. **Eight-hour law.**—The eight-hour labor statute cited in Article 11 of the construction contract does not apply to the procurement of supplies, materials, or articles which may usually be bought in the open market, whether made to conform to particular specifications or not, or to the construction or repair of levees or revetments necessary for protection against floods or overflows on the navigable waters of the United States, or to any emergency caused by fire, famine, or flood, by danger to life or to property, or by other extraordinary event or condition on account of which the President shall subsequently declare the violation to have been excusable.

25. **Patents.**—Unless specified by the Government, patented articles shall not knowingly be used in connection with the performance of the contract by the contractor, unless he is the owner or licensee thereof or procures the same in open market, or unless full information relative thereto shall have been furnished in his proposal. The contractor must notify the Government immediately of any claim or infringement of any patent in connection with the performance of the contract.

(These instructions are not to be incorporated in the contract)

GOVERNMENT PRINTING OFFICE 10—1772

Standard Form No. 23
Approved by the President
Nov. 19, 1926

STANDARD GOVERNMENT FORM OF CONTRACT

(CONSTRUCTION)

UNITED STATES DEPARTMENT OF AGRICULTURE
(Department)

(Contractor)

Contract for ..... *Amount, $*.....

Place .....

10—1771

This Contract, entered into this day of , 19 , by THE UNITED STATES OF AMERICA, hereinafter called the Government, represented by the contracting officer executing this contract, and

a corporation

organized and existing under the laws of the State of
a partnership consisting of

an individual trading as
of the city of in the State of
hereinafter called the contractor, witnesseth that the parties hereto do mutually agree as follows:

ARTICLE 1. *Statement of work.*—The contractor shall furnish all labor and materials, and perform all work required for

for the consideration of

in strict accordance with the specifications, schedules, and drawings, all of which are made a part hereof and designated as follows:

The work shall be commenced

and shall be completed

10—1771

Article 2. *Specifications and drawings.*—The contractor shall keep on the work a copy of the drawings and specifications and shall at all times give the contracting officer access thereto. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications shall be of like effect as if shown or mentioned in both. In case of difference between drawings and specifications, the specifications shall govern. In any case of discrepancy in the figures or drawings, the matter shall be immediately submitted to the contracting officer, without whose decision said discrepancy shall not be adjusted by the contractor, save only at his own risk and expense. The contracting officer shall furnish from time to time such detail drawings and other information as he may consider necessary, unless otherwise provided. Upon completion of the contract the work shall be delivered complete and undamaged.

Article 3. *Changes.*—The contracting officer may at any time, by a written order, and without notice to the sureties, make changes in the drawings and (or) specifications of this contract and within the general scope thereof. If such changes cause an increase or decrease in the amount due under this contract, or in the time required for its performance, an equitable adjustment shall be made and the contract shall be modified in writing accordingly. No change involving an estimated increase or decrease of more than Five Hundred Dollars shall be ordered unless approved in writing by the head of the department or his duly authorized representative. Any claim for adjustment under this article must be asserted within ten days from the date the change is ordered, unless the contracting officer shall for proper cause extend such time, and if the parties can not agree upon the adjustment the dispute shall be determined as provided in Article 15 hereof. But nothing provided in this article shall excuse the contractor from proceeding with the prosecution of the work so changed.

Article 4. *Changed conditions.*—Should the contractor encounter, or the Government discover, during the progress of the work, subsurface and (or) latent conditions at the site materially differing from those shown on the drawings or indicated in the specifications, the attention of the contracting officer shall be called immediately to such conditions before they are disturbed. The contracting officer shall thereupon promptly investigate the conditions, and if he finds that they materially differ from those shown on the drawings or indicated in the specifications, he shall at once, with the written approval of the head of the department or his representative, make such changes in the drawings and (or) specifications as he may find necessary, and any increase or decrease of cost and (or) difference in time resulting from such changes shall be adjusted as provided in Article 3 of this contract.

Article 5. *Extras.*—Except as otherwise herein provided, no charge for any extra work or material will be allowed unless the same has been ordered in writing by the contracting officer and the price stated in such order.

Article 6. *Inspection.*—(*a*) All material and workmanship (if not otherwise designated by the specifications) shall be subject to inspection, examination, and test by Government inspectors at any and all times during manufacture and (or) construction and at any and all places where such manufacture and (or) construction are carried on. The Government shall have the right to reject defective material and workmanship or require its correction. Rejected workmanship shall be satisfactorily corrected and rejected material shall be satisfactorily replaced with proper material without charge therefor, and the contractor shall promptly segregate and remove the same from the premises.

(*b*) The contractor shall furnish promptly without additional charge, all reasonable facilities, labor, and materials necessary for the safe and convenient inspection and test that may be required by the inspectors. All inspection and tests by the Government shall be performed in such manner as not to unnecessarily delay the work. Special, full size, and performance tests shall be as described in the specifications. The contractor shall be charged with any additional cost of inspection when material and workmanship is not ready at the time inspection is requested by the contractor.

(*c*) Should it be considered necessary or advisable by the Government at any time before final acceptance of the entire work to make an examination of work already completed, by removing or

tearing out same, the contractor shall on request promptly furnish all necessary facilities, labor, and material. If such work is found to be defective in any material respect, due to fault of the contractor or his subcontractors, he shall defray all the expenses of such examination and of satisfactory reconstruction. If, however, such work is found to meet the requirements of the contract, the actual cost of labor and material necessarily involved in the examination and replacement, plus 15 per cent, shall be allowed the contractor and he shall, in addition, if completion of the work has been delayed thereby, be granted a suitable extension of time on account of the additional work involved.

(*d*) Inspection of material and finished articles to be incorporated in the work at the site shall be made at the place of production, manufacture, or shipment, whenever the quantity justifies it, unless otherwise stated in the specifications; and such inspection and acceptance, unless otherwise stated in the specifications, shall be final, except as regards latent defects, departures from specific requirements of the contract and the specifications and drawings made a part thereof, damage or loss in transit, fraud, or such gross mistakes as amount to fraud. Subject to the requirements contained in the preceding sentence, the inspection of material and workmanship for final acceptance as a whole or in part shall be made at the site.

ARTICLE 7.—*Materials and workmanship.*—Unless otherwise specifically provided for in the specifications, all workmanship, equipment, materials, and articles incorporated in the work covered by this contract are to be of the best grade of their respective kinds for the purpose. Where equipment, materials, or articles are referred to in the specifications as "equal to" any particular standard, the contracting officer shall decide the question of equality. The contractor shall furnish to the contracting officer for his approval the name of the manufacturer of machinery, mechanical and other equipment which he contemplates installing, together with their performance capacities and other pertinent information. When required by the specifications, or when called for by the contracting officer, the contractor shall furnish the contracting officer for approval full information concerning the materials or articles which he contemplates incorporating in the work. Samples of materials shall be submitted for approval when so directed. Machinery, equipment, materials, and articles installed or used without such approval shall be at the risk of subsequent rejection. The contracting officer may require the contractor to dismiss from the work such employee as the contracting officer deems incompetent, careless, insubordinate, or otherwise objectionable.

ARTICLE 8. *Superintendence by contractor.*—The contractor shall give his personal superintendence to the work or have a competent foreman or superintendent, satisfactory to the contracting officer, on the work at all times during progress, with authority to act for him.

ARTICLE 9. *Delays—Damages.*—If the contractor refuses or fails to prosecute the work, or any separable part thereof, with such diligence as will insure its completion within the time specified in Article 1, or any extension thereof, or fails to complete said work within such time, the Government may, by written notice to the contractor, terminate his right to proceed with the work or such part of the work as to which there has been delay. In such event, the Government may take over the work and prosecute the same to completion by contract or otherwise, and the contractor and his sureties shall be liable to the Government for any excess cost occasioned the Government thereby. If the contractor's right to proceed is so terminated, the Government may take possession of and utilize in completing the work such materials, appliances, and plant as may be on the site of the work and necessary therefor. If the Government does not terminate the right of the contractor to proceed, the contractor shall continue the work, in which event the actual damages for the delay will be impossible to determine and in lieu thereof the contractor shall pay to the Government as fixed, agreed, and liquidated damages for each calendar day of delay until the work is completed or accepted the amount as set forth in the specifications or accompanying papers and the contractor and his sureties shall be liable for the amount thereof: *Provided,* That the right of the contractor to proceed shall not be terminated or the contractor charged with liquidated damages because of any delays in the completion of the work due to unforeseeable causes beyond the control and without the fault or negligence of the contractor, including, but not restricted to, acts of God, or of the public enemy, acts of the Government, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and unusually severe weather or delays of subcontractors due to such causes: *Provided further,* That the contractor shall within ten days from the beginning of any such delay notify the contracting officer in writing of the causes of delay, who shall ascertain the facts and the

extent of the delay, and his findings of facts thereon shall be final and conclusive on the parties hereto, subject only to appeal, within thirty days, by the contractor to the head of the department concerned, whose decision on such appeal as to the facts of delay shall be final and conclusive on the parties hereto.

Article 10. *Permits and care of work.*—The contractor shall, without additional expense to the Government, obtain all required licenses and permits and be responsible for all damages to persons or property that occur as a result of his fault or negligence in connection with the prosecution of the work, and shall be responsible for the proper care and protection of all materials delivered and work performed until completion and final acceptance.

Article 11. *Eight-hour law—Convict labor.*—(*a*) No laborer or mechanic doing any part of the work contemplated by this contract, in the employ of the contractor or any subcontractor contracting for any part of said work contemplated, shall be required or permitted to work more than eight hours in any one calendar day upon such work at the site thereof. For each violation of the requirements of this article a penalty of five dollars shall be imposed upon the contractor for each laborer or mechanic for every calendar day in which such employee is required or permitted to labor more than eight hours upon said work, and all penalties thus imposed shall be withheld for the use and benefit of the Government: *Provided*, That this stipulation shall be subject in all respects to the exceptions and provisions of the act of June 19, 1912 (37 Stat. 137), relating to hours of labor.

(*b*) The contractor shall not employ any person undergoing sentence of imprisonment at hard labor.

Article 12. *Covenant against contingent fees.*—The contractor warrants that he has not employed any person to solicit or secure this contract upon any agreement for a commission, percentage, brokerage, or contingent fee. Breach of this warranty shall give the Government the right to terminate the contract, or, in its discretion, to deduct from the contract price or consideration the amount of such commission, percentage, brokerage, or contingent fees. This warranty shall not apply to commissions payable by contractors upon contracts or sales secured or made through bona fide established commercial or selling agencies maintained by the contractor for the purpose of securing business.

Article 13.—*Other contracts.*—The Government may award other contracts for additional work, and the contractor shall fully cooperate with such other contractors and carefully fit his own work to that provided under other contracts as may be directed by the contracting officer. The contractor shall not commit or permit any act which will interfere with the performance of work by any other contractor.

Article 14. *Officials not to benefit.*—No Member of or Delegate to Congress, or Resident Commissioner, shall be admitted to any share or part of this contract or to any benefit that may arise therefrom, but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

Article 15. *Disputes.*—Except as otherwise specifically provided in this contract, all disputes concerning questions of fact arising under this contract shall be decided by the contracting officer or his duly authorized representative, subject to written appeal by the contractor within thirty days to the head of the department concerned, whose decision shall be final and conclusive upon the parties thereto as to such questions of fact. In the meantime the contractor shall diligently proceed with the work as directed.

Article 16. *Payments to contractors.*—(*a*) Unless otherwise provided in the specifications, partial payments will be made as the work progresses at the end of each calendar month, or as soon thereafter as practicable, on estimates made and approved by the contracting officer. In preparing estimates the material delivered on the site and preparatory work done may be taken into consideration.

(*b*) In making such partial payments there shall be retained 10 per cent on the estimated amount until final completion and acceptance of all work covered by the contract: *Provided, however*, That the

contracting officer, at any time after 50 per cent of the work has been completed, if he finds that satisfactory progress is being made, may make any of the remaining partial payments in full: *And provided further*, That on completion and acceptance of each separate building, vessel, public work, or other division of the contract, on which the price is stated separately in the contract, payment may be made in full, including retained percentages thereon, less authorized deductions.

(*c*) All material and work covered by partial payments made shall thereupon become the sole property of the Government, but this provision shall not be construed as relieving the contractor from the sole responsibility for the care and protection of materials and work upon which payments have been made or the restoration of any damaged work, or as a waiver of the right of the Government to require the fulfillment of all of the terms of the contract.

(*d*) Upon completion and acceptance of all work required hereunder, the amount due the contractor under this contract will be paid upon the presentation of a properly executed and duly certified voucher therefor, after the contractor shall have furnished the Government with a release, if required, of all claims against the Government arising under and by virtue of this contract, other than such claims, if any, as may be specifically excepted by the contractor from the operation of the release in stated amounts to be set forth therein.

ARTICLE 17. *Additional security.*—Should any surety upon the bond for the performance of this contract become unacceptable to the Government, the contractor must promptly furnish such additional security as may be required from time to time to protect the interests of the Government and of persons supplying labor or materials in the prosecution of the work contemplated by the contract.

ARTICLE 18. *Definitions.*—(*a*) The term "head of department" as used herein shall mean the head of the executive department or independent establishment involved, and "his representative" means any person authorized to act for him other than the contracting officer.

(*b*) The term "contracting officer" as used herein shall include his duly appointed successor or his duly authorized representative.

ARTICLE 19. *Alterations.*—The following changes were made in this contract before it was signed by the parties hereto:

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first-above written.

THE UNITED STATES OF AMERICA

By _____

_____
(Official title)

Two witnesses:

_____ _____ } *Contractor.*

_____ _____
(Business address)

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I, , certify that I am the secretary of the corporation named as contractor herein; that who signed this contract on behalf of the contractor, was then of said corporation; that said contract was duly signed for and in behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

---------- [CORPORATE SEAL]

I hereby certify that, to the best of my knowledge and belief, based upon observation and inquiry, who signed this contract for the had authority to execute the same, and is the individual who signs similar contracts on behalf of this corporation with the public generally.

---------- *Contracting Officer.*

This contract is authorized by the acts of

DIRECTIONS FOR PREPARATION OF CONTRACT

1. This form shall be used for every formal contract for the construction or repair of public buildings or works, but its use will not be required in foreign countries.

2. There shall be no deviation from this standard contract form, except as provided for in these directions, without prior approval of the Director of the Bureau of the Budget obtained through the Interdepartmental Board of Contracts and Adjustments. Where interlineations, deletions, additions, or other alterations are permitted, specific notation of the same shall be entered in the blank space following the article entitled "Alterations" before signing. This article is not to be construed as general authority to deviate from the standard form. Deletion of the descriptive matter not applicable in the preamble need not be noted in the article entitled "Alterations."

3. The blank space of Article 1 is intended for the insertion of a statement of the work to be done, together with place of performance, or for the enumeration of papers which contain the necessary data.

4. If it is deemed necessary to include an article on Patents the Invitation to Bidders shall so state and the following article be used:

> ARTICLE ____. *Patents.*—The contractor shall hold and save the Government, its officers, agents, servants, and employees, harmless from liability of any nature or kind for or on account of the use of any patented or unpatented invention, article, or appliance furnished or used in the performance of this contract, excepting patented articles required by the Government in its specifications, the use of which the contractor does not control.

5. Where only one payment is contemplated, upon completion of the contract, all except paragraph (*d*) of Article 16, "Payments to Contractor," must be stricken out.

6. If approval of the contract is required before it shall become binding, the following article must be added:

> ARTICLE ____. *Approval.*—This contract shall be subject to the written approval of---------- ---------- and shall not be binding until so approved.

Contracts subject to approval are not valid until approved by the authority designated to approve them, and the contractor's copy will not be delivered, nor any distribution made, until such approval. All changes and deletions must have been made before the contract is forwarded for approval.

7. The number of exectued copies and of certified copies, designation of disbursing officer, statement of appropriation, amount of bond, designation of place of inspection, as well as other administrative details, shall be as directed by the department to which the contract pertains.

8. All blank spaces must be filled in or ruled out. The contract must be dated, and the bond must bear the same or subsequent date.

9. An officer of a corporation, a member of a partnership, or an agent signing for the principal, shall place his signature and title after the word "By" under the name of the principal. A contract executed by an attorney or agent on behalf of the contractor shall be accompanied by two authenticated copies of his power of attorney, or other evidence of his authority to act on behalf of the contractor.

10. If the contractor is a corporation, one of the certificates following the signatures of the parties must be executed. If the contract is signed by the secretary of the corporation, then the first certificate must be executed by some other officer of the corporation under the corporate seal, or the second certificate executed by the contracting officer. In lieu of either of the foregoing certificates there may be attached to the contract copies of so much of the records of the corporation as will show the official character and authority of the officer signing, duly certified by the secretary or assistant secretary, under the corporate seal, to be true copies.

11. The full name and business address of the contractor must be inserted, and the contract signed with his usual signature. Typewrite or print name under all signatures to contract and bond.

12. The contracting officer must fill in the citation of the act authorizing the contract as indicated at the end of the last page of the contract.

13. The Invitation, Bid, Acceptance, and Instructions to Bidders are not to be incorporated in the contract.

14. The specifications should include a paragraph stating the amount of liquidated damages that will be paid by the contractor for each calendar day of delay, as indicated in Article 9 of the contract.

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Standard Form No. 24
Approved by the President
Nov. 19, 1926

STANDARD GOVERNMENT FORM OF BID BOND

(CONSTRUCTION OR SUPPLY)

Know all Men by these Presents, That we,

(See Instructions 4, 5, and 7)

as PRINCIPAL, and

as SURETY,

(See Instructions 2, 3, 4, and 7)

are held and firmly bound unto the United States of America, hereinafter called the Government, in the penal sum of

dollars

lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal has submitted the accompanying bid, dated , 19 , for

NOW, THEREFORE, if the principal shall not withdraw said bid within the period specified therein after the opening of the same, or, if no period be specified, within sixty (60) days after said opening, and shall within the period specified therefor, or, if no period be specified, within ten (10) days after the prescribed forms are presented to him for signature, enter into a written contract with the Government, in accordance with the bid as accepted, and give bond with good and sufficient surety or sureties, as may be required, for the faithful performance and proper fulfillment of such contract, or in the event of the withdrawal of said bid within the period specified, or the failure to enter into such contract and give such bond within the time specified, if the principal shall pay the Government the difference between the amount specified in said bid and the amount for which the Government may procure the required work and/or supplies, if the latter amount be in excess of the former, then the above obligation shall be void and of no effect, otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals this day of , 19 , the name and corporate seal

of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In presence of—

---------- ---------- [SEAL]
(Individual principal)

---------- ----------
(Address) (Business address)

---------- ---------- [SEAL]
(Individual principal)

---------- ----------
(Address) (Business address)

---------- ---------- [SEAL]
(Individual surety)

---------- ----------
(Address) (Business address)

---------- ---------- [SEAL]
(Individual surety)

---------- ----------
(Address) (Business address)

Attest:

(Corporate principal)

(Business address)

---------- By ---------- [AFFIX CORPORATE SEAL]

Attest:

(Corporate surety)

(Business address)

---------- By ---------- [AFFIX CORPORATE SEAL]

The rate of premium on this bond is ---------- per thousand.

Total amount of premium charged, $ ----------

(The above must be filled in by corporate surety)

GOVERNMENT PRINTING OFFICE

CERTIFICATE AS TO CORPORATE PRINCIPAL

I, , certify that I am the secretary of the corporation named as principal in the within bond; that , who signed the said bond on behalf of the principal was then of said corporation; that I know his signature, and his signature thereto is genuine; and that said bond was duly signed, sealed, and attested for and in behalf of said corporation by authority of its governing body.

---------- [CORPORATE SEAL]

AFFIDAVIT BY INDIVIDUAL SURETY

STATE OF----------
} *ss:*
COUNTY OF----------

I, , being duly sworn, depose and say that I am one of the sureties to the foregoing bond; that I am a citizen of the United States, and of full age and legally competent; that I reside at
and that I am worth in real estate and personal property the sum of
dollars, over and above (1) all my debts and liabilities, owing and incurred, (2) any property exempt from execution, (3) and aggregate full penalties on all other bonds on which I am surety, and (4) any pecuniary interest I have in the business of the principal on said bond; that I own, unincumbered, real estate, the fee of which is in my name, worth dollars, located in ; that said property is not exempt from seizure and sale under any homestead law, community, or marriage law, or upon any attachment, execution, or judicial process, and that I am not surety on any other bonds, except as follows:

(State character and amount of each bond. If not on other bonds, so state)

---------- (Surety's signature)

Subscribed and sworn to before me this day of , 19 ,

at

[OFFICIAL SEAL] ---------- (Title of official administering oath)

AFFIDAVIT BY INDIVIDUAL SURETY

STATE OF _____ }
} ss:
COUNTY OF _____ }

I, _____, being duly sworn, depose and say that I am one of the sureties to the foregoing bond; that I am a citizen of the United States, and of full age and legally competent; that I reside at
and that I am worth in real estate and personal property the sum of
_____ dollars, over and above (1) all my debts and liabilities, owing and incurred, (2) any property exempt from execution, (3) the aggregate full penalties on all other bonds on which I am surety, and (4) any pecuniary interest I have in the business of the principal on said bond; that I own, unincumbered, real estate, the fee of which is in my name, worth
_____ dollars, located in
_____; that said property is not exempt from seizure and sale under any homestead law, community, or marriage law, or upon any attachment, execution, or judicial process; and that I am not surety on any other bonds, except as follows:

_____
(State character and amount of each bond. If not on other bonds, so state)

_____

_____

_____

_____
(Surety's signature)

Subscribed and sworn to before me this _____ day of _____ 19 _____, at _____

_____

[OFFICIAL SEAL]

_____
(Title of official administering oath)

CERTIFICATE OF SUFFICIENCY

I, _____, do hereby certify that one of the sureties named above, is personally known to me, and that, to the best of my knowledge and belief, the facts stated by such surety in the foregoing affidavit are true.

_____

_____
(Address)

CERTIFICATE OF SUFFICIENCY

I, _____ do hereby certify that one of the sureties named above, is personally known to me, and that, to the best of my knowledge and belief, the facts stated by such surety in the foregoing affidavit are true.

_____

_____
(Address)

10—1773

INSTRUCTIONS

1. This form shall be used for construction work or the furnishing of supplies, whenever a bond is required.

2. The surety on the bond for any bid or for the performance of the contract may be any corporation authorized by the Secretary of the Treasury to act as surety, or two responsible individual sureties. Individual sureties shall justify in sums aggregating not less than double the penalty of the bond.

3. A firm, as such, will not be accepted as a surety, nor a partner for copartners or for a firm of which he is a member. Stockholders of a corporate principal may be accepted as sureties provided their qualifications as such are independent of their stock holdings therein. Sureties, if individuals, shall be citizens of the United States, except that sureties on bonds executed in any foreign country, the Canal Zone, the Philippine Islands, Porto Rico, Hawaii, Alaska, or any possession of the United States, for the performance of contracts entered into in these places, need not be citizens of the United States, but if not citizens of the United States shall be domiciled in the place where the contract is to be performed.

4. The name, including full Christian name, and residence of each individual party to the bond shall be inserted in the body thereof, and each such party shall sign the bond with his usual signature on the line opposite the scroll seal, and if signed in Maine, Massachusetts, or New Hampshire, an adhesive seal shall be affixed opposite the signature.

5. If the principals are partners, their individual names shall appear in the body of the bond, with the recital that they are partners composing a firm, naming it, and all the members of the firm shall execute the bond as individuals.

6. The signature of a witness shall appear in the appropriate place, attesting the signature of each individual party to the bond.

7. If the principal or surety is a corporation, the name of the State in which incorporated shall be inserted in the appropriate place in the body of the bond, and said instrument shall be executed and attested under the corporate seal as indicated in the form. If the corporation has no corporate seal the fact shall be stated, in which case a scroll or adhesive seal shall appear following the corporate name.

8. The official character and authority of the person or persons executing the bond for the principal, if a corporation, shall be certified by the secretary or assistant secretary, according to the form attached thereto. In lieu of such certificate there may be attached to the bond copies of so much of the records of the corporation as will show the official character and authority of the officer signing, duly certified by the secretary or assistant secretary, under the corporate seal, to be true copies.

9. Each individual surety shall justify, under oath, according to the form appearing on the bond, before a United States commissioner, a clerk of a United States court, a notary public, or some other officer having authority to administer oaths generally. If the officer has an official seal it shall be affixed, otherwise the proper certificate as to his official character shall be furnished. Where citizenship is not required, as provided in paragraph 3 of these Instructions, the affidavit may be amended accordingly.

10. The certificate of sufficiency shall be signed by a judge or clerk of a court of record, a United States district attorney or commissioner, or the president or cashier of a bank or trust company.

11. The date of the bond must not be prior to the date of the instrument for which it is given.

10—1773

Standard Form No. 25
Approved by the President
Nov. 19, 1926

STANDARD GOVERNMENT FORM OF PERFORMANCE BOND

(CONSTRUCTION OR SUPPLY)

Know all Men by these Presents, That we,

(See Instructions 4, 5, and 7)

as PRINCIPAL, and

as SURETY,

(See Instructions 2, 3, 4, and 7)

are held and firmly bound unto the United States of America, hereinafter called the Government, in the penal sum of

dollars

lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, and successors, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the principal entered into a certain contract, hereto attached, with the Government, dated , 19 , for

NOW THEREFORE, If the principal shall well and truly perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of said contract during the original term of said contract and any extensions thereof that may be granted by the Government, with or without notice to the surety, and during the life of any guaranty required under the contract, and shall also well and truly perform and fulfill all the undertakings, covenants, terms, conditions and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the surety being hereby waived, and if said contract is for the construction or repair of a public building or a public work within the meaning of the act of August 13, 1894, as amended by act of February 25, 1905, shall promptly make payment to all persons supplying the principal with labor and materials in the prosecution of the work provided for in said contract, and any such authorized extension or modification thereof, then, this obligation to be void; otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above-bounden parties have executed this instrument under their several seals this day of , 19 , the name and corporate seal

of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In presence of—

_____ _____ [SEAL]
(Individual principal)

_____ _____
(Address) (Business address)

_____ _____ [SEAL]
(Individual principal)

_____ _____
(Address) (Business address)

_____ _____ [SEAL]
(Individual surety)

_____ _____
(Address) (Business address)

_____ _____ [SEAL]
(Individual surety)

_____ _____
(Address) (Business address)

Attest:

_____
(Corporate principal)

_____
(Business address)

_____ By _____ [AFFIX CORPORATE SEAL]

Attest:

_____
(Corporate surety)

_____
(Business address)

_____ By _____ [AFFIX CORPORATE SEAL]

The rate of premium on this bond is _____ per thousand.

Total amount of premium charged, $ _____

(The above must be filled in by corporate surety)

GOVERNMENT PRINTING OFFICE

CERTIFICATE AS TO CORPORATE PRINCIPAL

I, , certify that I am the secretary of the corporation named as principal in the within bond; that , who signed the said bond on behalf of the principal was then of said corporation; that I know his signature, and his signature thereto is genuine; and that said bond was duly signed, sealed, and attested for and in behalf of said corporation by authority of its governing body.

---------- [CORPORATE SEAL]

AFFIDAVIT BY INDIVIDUAL SURETY

STATE OF ----------
} *ss:*
COUNTY OF ----------

I, , being duly sworn, depose and say that I am one of the sureties to the foregoing bond; that I am a citizen of the United States, and of full age and legally competent; that I reside at
and that I am worth in real estate and personal property the sum of
dollars, over and above (1) all my debts and liabilities, owing and incurred, (2) any property exempt from execution, (3) and aggregate full penalties on all other bonds on which I am surety, and (4) any pecuniary interest I have in the business of the principal on said bond; that I own, unincumbered, real estate, the fee of which is in my name, worth dollars, located in ; that said property is not exempt from seizure and sale under any homestead law, community, or marriage law, or upon any attachment, execution, or judicial process, and that I am not surety on any other bonds, except as follows:

(State character and amount of each bond. If not on other bonds, so state)

---------- (Surety's signature)

Subscribed and sworn to before me this day of , 19 ,

at

[OFFICIAL SEAL] ---------- (Title of official administering oath)

AFFIDAVIT BY INDIVIDUAL SURETY

STATE OF _____ }
COUNTY OF _____ } *ss*:

I, _____, being duly sworn, depose and say that I am one of the sureties to the foregoing bond; that I am a citizen of the United States, and of full age and legally competent; that I reside at _____ and that I am worth in real estate and personal property the sum of _____ dollars, over and above (1) all my debts and liabilities, owing and incurred, (2) any property exempt from execution, (3) the aggregate full penalties on all other bonds on which I am surety, and (4) any pecuniary interest I have in the business of the principal on said bond; that I own, unincumbered, real estate, the fee of which is in my name, worth _____ dollars, located in _____; that said property is not exempt from seizure and sale under any homestead law, community, or marriage law, or upon any attachment, execution, or judicial process; and that I am not surety on any other bonds, except as follows:

_____
(State character and amount of each bond. If not on other bonds, so state)

_____

_____

_____

_____
(Surety's signature)

Subscribed and sworn to before me this _____ day of _____ 19 , at _____

_____

[OFFICIAL SEAL]

_____
(Title of official administering oath)

CERTIFICATE OF SUFFICIENCY

I, _____, do hereby certify that _____ one of the sureties named above, is personally known to me, and that, to the best of my knowledge and belief, the facts stated by such surety in the foregoing affidavit are true.

_____

_____
(Address)

CERTIFICATE OF SUFFICIENCY

I, _____ do hereby certify that _____ one of the sureties named above, is personally known to me, and that, to the best of my knowledge and belief, the facts stated by such surety in the foregoing affidavit are true.

_____

_____
(Address)

10—1773

INSTRUCTIONS

1. This form shall be used for construction work or the furnishing of supplies, whenever a bond is required.

2. The surety on the bond for any bid or for the performance of the contract may be any corporation authorized by the Secretary of the Treasury to act as surety, or two responsible individual sureties. Individual sureties shall justify in sums aggregating not less than double the penalty of the bond.

3. A firm, as such, will not be accepted as a surety, nor a partner for copartners or for a firm of which he is a member. Stockholders of a corporate principal may be accepted as sureties provided their qualifications as such are independent of their stock holdings therein. Sureties, if individuals, shall be citizens of the United States, except that sureties on bonds executed in any foreign country, the Canal Zone, the Philippine Islands, Porto Rico, Hawaii, Alaska, or any possession of the United States, for the performance of contracts entered into in these places, need not be citizens of the United States, but if not citizens of the United States shall be domiciled in the place where the contract is to be performed.

4. The name, including full Christian name, and residence of each individual party to the bond shall be inserted in the body thereof, and each such party shall sign the bond with his usual signature on the line opposite the scroll seal, and if signed in Maine, Massachusetts, or New Hampshire, an adhesive seal shall be affixed opposite the signature.

5. If the principals are partners, their individual names shall appear in the body of the bond, with the recital that they are partners composing a firm, naming it, and all the members of the firm shall execute the bond as individuals.

6. The signature of a witness shall appear in the appropriate place, attesting the signature of each individual party to the bond.

7. If the principal or surety is a corporation, the name of the State in which incorporated shall be inserted in the appropriate place in the body of the bond, and said instrument shall be executed and attested under the corporate seal as indicated in the form. If the corporation has no corporate seal the fact shall be stated, in which case a scroll or adhesive seal shall appear following the corporate name.

8. The official character and authority of the person or persons executing the bond for the principal, if a corporation, shall be certified by the secretary or assistant secretary, according to the form attached thereto. In lieu of such certificate there may be attached to the bond copies of so much of the records of the corporation as will show the official character and authority of the officer signing, duly certified by the secretary or assistant secretary, under the corporate seal, to be true copies.

9. Each individual surety shall justify, under oath, according to the form appearing on the bond, before a United States commissioner, a clerk of a United States court, a notary public, or some other officer having authority to administer oaths generally. If the officer has an official seal it shall be affixed, otherwise the proper certificate as to his official character shall be furnished. Where citizenship is not required, as provided in paragraph 3 of these Instructions, the affidavit may be amended accordingly.

10. The certificate of sufficiency shall be signed by a judge or clerk of a court of record, a United States district attorney or commissioner, or the president or cashier of a bank or trust company.

11. The date of the bond must not be prior to the date of the instrument for which it is given.

10—1774

F. R. 50 B

Bidders will furnish on the following form a statement covering experience on similar work, a list of equipment available for the proposed work, and a statement of financial resources. This information must show the bidder to be qualified for the work to be undertaken or bid may be rejected.

STATEMENT

OF

BIDDER'S QUALIFICATIONS

CONSTRUCTING HIGHWAY PROJECTS

Submitted by .....

Address .....

.....

With bid for .....
(Type of improvement)

of the .....
(Project name)

Number ....., located in the State of .....

County of ....., to be opened and read at ..... o'clock ..... M.,

on the ..... day of ....., 19.....

It is understood that unless the bidder is one of the three low bidders, this statement will not be examined but will be returned to the bidder at the same time as the bid guaranty.

☐ A corporation.

Submitted by _____ ☐ A copartnership.

☐ An individual.

Principal office address } Street _____, City _____, State _____

The signatory of this questionnaire guarantees the truth and accuracy of all statements and of all answers to interrogatories hereinafter made.

Corporations, answer this:	*Copartnerships, answer this:*
Cash capital paid in _____	Date of organization _____
When incorporated _____	
In what State _____	Name and address of partners: *Age*
President's name _____	(1) _____ _____
Vice president's name _____	(2) _____ _____
Secretary's name _____	(3) _____ _____
Treasurer's name _____	(4) _____ _____

1. How many years has your organization been engaged in contract work under your present name? _____
   In highway construction work? _____
2. List below last six contracts completed by your organization:

	Agency	Time to Complete			Outcome	
	(Government, State, county, city, etc.)	Contract amount	Date started	Date completed	Profit	Loss
(1)						
(2)						
(3)						
(4)						
(5)						
(6)						

3. Have you or any officers or partners of your organization ever failed to complete any construction work awarded to you or them either as a member of your organization or as an officer or partner of some other organization? _____ If so, give full details _____

4. In what other lines of business are you financially interested? ---

5. Indicate below the history of your organization in effecting final adjustment of contract on last three contracts:

Project	Date Completed	Amount Final Estimate	Date Final Estimate Received	Date Signed	Reasons For Delay
(1)					
(2)					
(3)					

6. To what extent have you inspected the proposed work? Explain in detail: ---

7. Explain your plan or layout for performing the proposed work and under whose supervision will the work be performed: ---

8. List below the equipment you own which is immediately available for the proposed work:

Quantity	Item	Description, Size, Etc.	Condition	Years Service	Present Location

9. If you do not own the equipment necessary to prosecute the work according to your proposed plan or layout, how then do you propose to obtain it and what is your ability to finance purchase or rental? ---

Dated at _____ this _____

day of _____, 19_____
(Month)

_____
(Name of organization)

By _____
(Title of person signing)

STATE OF _____ }
COUNTY OF _____ } *ss:*

_____, being duly sworn, deposes and says that he

is _____ of _____
(Name of organization)

and that the answers to the foregoing questions and all statements therein contained are true and correct.

Sworn to before me this _____ day of _____, 19_____

_____
Notary Public.

My commission expires _____

CONTRACTOR'S FINANCIAL STATEMENT

Condition at close of business _____, 19____

ASSETS	Dollars	Cents
1. Cash: (*a*) On hand, $_____; (*b*) in bank, $_____; (*c*) elsewhere, $_____		
2. Notes receivable: (*a*) Due within 90 days		
(*b*) Due after 90 days		
(*c*) Past due		
3. Accounts receivable from completed contracts approved for payment		
4. Sums earned on uncompleted contracts as shown by engineer's or architect's estimate:		
(*a*) Amount receivable after deducting amount retained		
(*b*) Amount retained to date, due upon completion of contracts		
5. Accounts receivable from sources other than construction contracts		
6. Deposits for bids or other guarantees: (*a*) Recoverable within 90 days		
(*b*) Recoverable after 90 days		
7. Interest accrued on loans, securities, etc		
8. Real estate: (*a*) Used for business purposes		
(*b*) Not used for business purposes		
9. Stocks and bonds: (*a*) Listed—present market value		
(*b*) Unlisted—present value		
10. Materials in stock not included in Item 4: (*a*) For uncompleted contracts (present value)		
(*b*) Other materials (present value)		
11. Equipment, book value		
12. Furniture and fixtures, book value		
13. Other assets		
TOTAL ASSETS		
LIABILITIES		
1. Notes payable: (*a*) To banks, regular		
(*b*) To banks for certified checks		
(*c*) To others for equipment obligations		
(*d*) To others exclusive of equipment obligations		
2. Accounts payable: (*a*) Not past due		
(*b*) Past due		
3. Real estate encumbrances		
4. Other liabilities		
5. Reserves		
6. Capital stock paid up: (*a*) Common		
(*b*) Common		
(*c*) Preferred		
(*d*) Preferred		
7. Surplus (net worth)		
TOTAL LIABILITIES		
CONTINGENT LIABILITIES		
1. Liability on notes receivable, discounted, or sold		
2. Liability on accounts receivable, pledged, assigned, or sold		
3. Liability as bondsman		
4. Liability as guarantor on contracts or on accounts of others		
5. Other contingent liabilities		
TOTAL CONTINGENT LIABILITIES		

N. B.—When deemed necessary the bidder will be required to furnish detailed data in support of any or all of the items noted.

AFFIDAVIT FOR INDIVIDUAL

STATE OF _____ }
} *ss:*
COUNTY OF _____ }

_____, being duly sworn, deposes and says that the foregoing financial statement, taken from his books, is a true and accurate statement of his financial condition as of the date thereof, and that the answers to the foregoing interrogatories are true.

_____
(Applicant must sign here)

Sworn to before me this _____ day of _____, 19_____

_____
Notary Public.

AFFIDAVIT FOR COPARTNERSHIP

STATE OF _____ }
} *ss:*
COUNTY OF _____ }

_____, being duly sworn, deposes and says that he is a member of the firm of _____; that he is familiar with the books of the said firm showing its financial condition; that the foregoing financial statement, taken from the books of the said firm, is a true and accurate statement of the financial condition of the said firm as of the date thereof, and that the answers to the foregoing interrogatories are true.

_____
(Members of firm must sign here)

Sworn to before me this _____ day of _____, 19_____

_____
Notary Public.

AFFIDAVIT FOR CORPORATION

STATE OF _____ }
} *ss:*
COUNTY OF _____ }

_____, being duly sworn, deposes and says that he is _____ of the _____ the corporation described in and which executed the foregoing statement; that he is familiar with the books of the said corporation showing its financial condition; that the foregoing financial statement, taken from the books of the said corporation, is a true and accurate statement of the financial condition of the said corporation as of the date thereof, and that the answers to the foregoing interrogatories are true.

_____
(Officer must sign here)

Sworn to before me this _____ day of _____, 19_____

_____
Notary Public.

GOVERNMENT PRINTING OFFICE

SPECIAL PROVISIONS

Bidders please note: Before preparing this proposal read carefully "Invitation to Bidders" and "Instructions to Bidders."

BID SCHEDULE

The following is the itemized bid:

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
1	----------	Acres clearing at---------- ----------per acre		
2	----------	Acres grubbing at---------- ----------per acre		
3	----------	Cu. yds. unclassified excavation at---------- ----------per cu. yd.		
4	----------	Cu. yds. common excavation at---------- ----------per cu. yd.		
5	----------	Cu. yds. solid rock excavation at---------- ----------per cu. yd.		
6	----------	Cu. yds. unclassified excavation for structures at---------- ----------per cu. yd.		
7	----------	---------- ---------- ----------		
8	----------	Station yds. overhaul at---------- ----------per station yd.		
9	----------	Cu. yds. sub-base in place at---------- ----------per cu. yd.		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
10	.....	Miles finishing earth graded road at .... per mile		
11	.....	Miles fine grading subgrade and shoulders at .... per mile		
12	.....	Cu. yds. crushed rock or crushed gravel bottom course at .... per cu. yd.		
13	.....	Cu. yds. crushed rock or crushed gravel top course at .... per cu. yd.		
14	.....	Cu. yds. miles binder hauled over 500 feet per cu. yd. mile at twenty-five cents.	0.25	
15	.....	Providing and maintaining water plant or plants on the job ..... A lump sum		
16	.....	Thousand gallons watering at .... per 1,000 gallons		
17	.....	Providing and maintaining roller on the job .... a lump sum		
18	.....	Operation of roller for days actually operated only, including operator, oil, gas, coal, etc. at .... per day		
19	.....	Cu. yds. gravel for bottom course at .... per cu. yd.		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
20		Cu. yds. gravel for top course at per cu. yd.		
21		Cu. yds. supplemental crushed rock or crushed gravel at per cu. yd.		
22		Cu. yds. supplemental gravel at per cu. yd.		
23				
24		M ft. B. M. untreated timber in place at per M.		
25		M ft. B. M. treated timber in place at per M.		
26		ft. span timber trusses complete in place at per span		
27		ft. span timber trusses complete in place at per span		
28		ft. span timber trusses complete in place at per span		
29		Timber bumpers, at each		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
30		____ft. span log bridges complete in place at ____ per span		
31		____ft. span log bridges complete in place at ____ per span		
32		____ft. span log bridges complete in place at ____ per span		
33		Lin. ft. of logs in log timber bents, at ____ per lin. ft.		
34		Sq. ft. of log cribbing in place at ____ per sq. ft.		
35		Lin. ft.____ log culverts in place at ____ per lin. ft.		
36		Lin. ft.____ log culverts in place at ____ per lin. ft.		
37		Lin. ft.____ log culverts in place at ____ per lin. ft.		
38		Cu. yds. Class A concrete at ____ per cu. yd.		
39		Cu. yds. Class B concrete at ____ per cu. yd.		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
40	----------	Cu. yds. Class C concrete at ---------- ---------- per cu. yd.		
41	----------	Cu. yds. Class D concrete at ---------- ---------- per cu. yd.		
42	----------	---------- ---------- ----------		
43	----------	Pounds reinforcing steel ---------- at ---------- ---------- per lb.		
44	----------	Phosphor bronze or bronze bearing plates at ---------- ---------- per lb.		
45	----------	Cu. yds. cement rubble masonry at ---------- ---------- per cu. yd.		
46	----------	Cu. yds. dry rubble masonry at ---------- ---------- per cu. yd.		
47	----------	Lin. ft. of ---------- inch concrete pipe in place at ---------- ---------- per lin. ft.		
48	----------	Lin. ft. of ---------- inch concrete pipe in place at ---------- ---------- per lin. ft.		
49	----------	Lin. ft. of ---------- inch concrete pipe in place at ---------- ---------- per lin. ft.		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amouut bid
50	----------	Lin. ft. of ---------- inch concrete pipe in place at ---------- ----------per lin. ft.		
		Corrugated galvanized metal pipe to be furnished under items 51 to 55, will be of the following brands: ---------- ---------- ---------- (To be filled in by the bidder)		
51	----------	Lin. ft. of---------inch corrugated galvanized metal pipe in place at---------- ----------per lin. ft.		
52	----------	Lin. ft. of---------inch corrugated galvanized metal pipe in place at---------- ----------per lin. ft.		
53	----------	Lin. ft. of---------inch corrugated galvanized metal pipe in place at---------- ----------per lin. ft.		
54	----------	Lin. ft. of---------inch corrugated galvanized metal pipe in place at---------- ----------per lin. ft.		
55	----------	Lin. ft. of---------inch corrugated galvanized metal pipe in place at---------- ----------per lin. ft.		
56	----------	Lbs. structural steel in place at ---------- ----------per lb.		
57	----------	Lin. ft. of untreated timber piling in place at ---------- ----------per lin. ft.		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
58		Lin. ft. of treated timber piling in place at _____ per lin. ft.		
59		Lin. ft. of concrete piling in place at _____ per lin. ft.		
60				
61		Cu. yds. hand-laid riprap in place at _____ per cu. yd.		
62		Cu. yds. hand-laid rock embankment at _____ per cu. yd.		
63		Lin. ft. of 6-inch vitrified tile underdrain in place at _____ per lin. ft.		
64		Lin. ft. of 6-inch porous tile underdrain in place at _____ per lin. ft.		
65		Lin. ft. of blind drain in place at _____ per lin. ft.		
66		Lin. ft. of wood guard rail in place at _____ per lin. ft.		
67		Lin. ft. of cable guard rail in place at _____ per lin. ft.		

Bid Schedule—Continued

Item	Approximate quantity	Items with unit bid price written in words	Unit bid price	Amount bid
68				
69				
70				
71				
72				
73				

GOVERNMENT PRINTING OFFICE

FORM F. R. 30

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

SPECIFICATIONS

FOR

FOREST ROAD CONSTRUCTION

REVISED 1929

WASHINGTON, D. C.
1929

CONTENTS

GENERAL REQUIREMENTS AND COVENANTS

DEFINITION OF TERMS

In these specifications and in related forms, the intent and meaning of the following terms shall be interpreted as follows:

Secretary. - The Secretary of that Department of the United States in which the contract is executed.

Chief of Bureau. - The Chief of the Bureau of Public Roads of the United States Department of Agriculture, who is hereby designated an authorized representative of the head of the Department.

Chief Engineer. - The chief engineer of the Bureau of Public Roads of the United States Department of Agriculture.

Engineer. - The district engineer of the Bureau of Public Roads of the United States Department of Agriculture in whose district the proposed improvement is to be located.

Contracting Officer. - The officer signing the contract upon behalf of the United States of America. The Chief of Bureau, chief engineer, and engineer are hereby designated as authorized representatives of the contracting officer.

Inspector. - An authorized representative of the engineer, assigned to make any or all necessary inspections of the work performed and materials furnished by the contractor.

Bidder. - Any individual, firm, or corporation submitting a bid for the work contemplated, acting directly or through a duly authorized representative.

Contractor. - Party of the second part to the contract, acting directly or through an authorized lawful agent or employee.

Surety. - The individuals or company signing, as guarantors, the performance bond furnished by the contractor.

Bid. - The approved prepared form on which the bidder has submitted in detail the statement of his offer to perform the work.

Bid Guaranty. - The required security submitted with the bid to insure the execution of contract and bond for the performance of the work if the bid is accepted.

Plans. - The approved official drawings of any and every kind or reproductions thereof which show the work to be done.

Specifications. - The directions, provisions, and requirements contained herein as may be supplemented by "Special Provisions" pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the contract.

Special Provisions. - Specifications and requirements pertaining to work proposed but not covered in the general specifications.

Supplemental Agreements. - Written contracts executed by the contractor and the contracting officer modifying the contract to cover changes or changed conditions incidental and (or) necessary to the project.

Contract. - The agreement between the United States of America by the contracting officer and the contractor covering the performance of the work and furnishing of materials in the construction thereof. The contract shall include the drawings, specifications and special provisions, proposal, and all supplemental agreements which are required to complete the construction of the roadway in a substantial manner.

Performance Bond. - The security furnished by the contractor to guarantee the completion of the work in accordance with the terms of the contract.

Highway. - The whole right of way which is reserved for use in constructing the roadway, and its appurtenances.

Roadbed. - The proportion of the roadway between the outside shoulder lines.

Roadway. - That portion of the highway included between the outside lines of gutters or side ditches, including also the appertaining structures and all slopes, ditches, channels, waterways, etc., necessary to proper drainage and protection.

Subgrade. - That portion of the roadbed upon which the wearing course or pavement is placed.

Bridges. - Structures of over 20-foot span measured under the copings, and parallel to the center line of the road, and multiple-span structures where the individual spans are in excess of 10 feet. The width of bridges is the distance between inside faces of curb.

Culverts. - Structures of spans less than the minimum spans defined for bridges.

Bridge Complete. - The entire structure, including both substructure and superstructure.

Substructure. - All of that part of the structure below the bridge seats or below the spring line of arches. Parapets and backwalls of abutments and wingwalls shall be considered as parts of the substructure.

Superstructure. - All of that part of the structure above the bridge seats or above the spring line of arches.

Laboratory. - The laboratories of the Bureau of Public Roads or other laboratories designated by the engineer.

The Work. - All the work specified or mentioned herein or indicated on the drawings.

Subsurface and (or) Latent Conditions at the Site. - The words "Subsurface and (or) latent conditions at the site" as used in Article 4 (first sentence) of the contract (Standard Form No. 23) shall be construed to mean and to refer solely to conditions of an unusual nature differing materially from those ordinarily encountered and generally recognized as inhering in work of the character provided for in the plans and specifications.

SCOPE OF WORK

Intent of Plans and Specifications. - The intent is to prescribe a complete work or improvement which the contractor undertakes to do, in full compliance with the plans, these specifications, the special provisions, bid and contract. The contractor shall perform the work in accordance with the lines, grades, typical cross sections, and dimensions shown on the plans or as modified by written orders involving "changes" or imposed as a result of "changed conditions"; he shall furnish, unless otherwise provided in the specifications or in the contract, all materials, implements, machinery, equipment, tools, supplies, and labor necessary to the prosecution of the work.

Maintenance of Detours. - Wherever so stated in the plans or in the "Special Provisions", the roadway throughout construction shall be maintaiued in such condition as to permit traffic to pass without undue inconvenience and the contractor shall assume any expense entailed in fulfilling this requirement. When any substantial portion or feature of the project is completed it shall be designated as "accepted for traffic" previous to the completion of the whole project if and as deemed expedient by the engineer. The contractor shall not assume any expense entailed in maintaining traffic over any portion of the project "accepted for traffic" but shall be compensated therefor as provided for detours. There shall be provided and maintained in passable condition such detours, temporary highways, and bridges as may be necessary to accomodate the general public, residents adjacent to the improvement, and the United States mails. Temporary approaches and crossings of intersecting highways shall be provided and maintained in a safe condition. The detours shall be located as directed by the engineer. The construction and maintenance of detours shall be paid for under the item in the bid schedule, "Maintenance of Detours", in the manner provided hereinafter in the "Extra and Force Account" clause.

Removal and Disposal of Structures and Obstructions. - All fences, buildings, structures, or encumbrances of any character upon or within the limits of the right of way, not necessary to the improvement, shall be removed by the contractor and carefully placed on the abutting property or otherwise disposed of, if and as required.

Rights in and Use of Materials Found on the Work. - The contractor may use in the proposed construction suitable stone, gravel, or sand found in the excavation and will be paid for the excavation of such materials at the corresponding contract unit price therefor, but he shall replace at his own expense with other suitable material all of that portion of the material so removed and used as was contemplated for use in the embankments, back-fills, approaches, or otherwise. No charge for materials so used will be made against the contractor except the replacenent herein provided for. The contractor shall not excavate or remove any material from within the highway location which is not within the excavation, as indicated by the slope and grade lines, without written authorization from the engineer.

Final Cleaning Up. - Before acceptance and final payment shall be made, the right of way, borrow pits, and all ground occupied by the contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, and equipment, and all parts of the work shall be left in a neat and presentable condition.

CONTROL OF THE WORK

Plans. - The approved plans or drawings shall be supplemented by such working drawings as are necessary to adequately control the work. It is mutually agreed that all authorized alterations affecting the requirements and information given on the approved plans shall be in writing.

Working drawings for any structure shall consist of such detailed plans as may be required for the prosecution of the work and are not included in the plans furnished by the engineer. They shall include shop details, erection plans, masonry layout diagrams, and bending diagrams for reinforcing steel, approval of which by the engineer must be obtained before any work involving these plans shall be performed. Plans for cribs, cofferdams, falsework, centering, and form work may also be required and in such case shall be likewase subject to approval by the engineer, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement. Tne contract price shall include the cost of furnishing all working drawings.

Conformity with Plans and Allowable Deviations. - Finished surfaces in all cases shall conform with lines, grades, cross sections, and dimensions shown on the approved plans. The crown, or rise, of the finished surface of the roadbed shall be as shown on the typical cross section of the plans, except at intersecting highways or wherever, to insure correct drainage or for other reasons, changes may be directed. On curves or at other places, where deemed necessary, the contractor may be required to superelevate the roadbed. Such other deviations from the plans and approved working drawings as may be required by the exigencies of construction will in all cases be determined by the engineer and authorized in writing.

Coordination of Plans, Specifications and "Special Provisions". - These specifications, the accompanying plans, "Special Provisions", and all supplementary documents are essential parts of the contract. They are intended to be mutually supplementary. In case of discrepancy, figured dimensions shall govern over scaled dimensions, "Special Provisions" shall govern over other specifications and over plans. In case of conflict between the plans or general specifications and such standard forms approved by the President on November 19, 1926, as are involved in the contract, the provisions of the said standard forms shall govern.

Construction Stakes. - The engineer will furnish and set construction stakes establishing lines, slopes, and continuous profile-grade in road work, and center line and bench marks for bridge work, and will furnish the contractor with all necessary information relating to lines, slopes, and grades. The contractor shall furnish, free of charge, all additional stakes, all templates, and other materials necessary for marking and maintaining points and lines given, and shall furnish the engineer such labor as he may require in establishing points and lines necessary to the prosecution of the work. The contractor shall be held responsible for the preservation of all stakes and marks, and if any of the construction stakes or marks have been carelessly or willfully destroyed or disturbed by the contractor, the cost of replacing them shall be charged against, and shall be deducted from, the payment for the work.

Final Inspection. - Whenever the work provided and contemplated by the contract shall have been satisfactorily completed and the final cleaning up performed, the engineer shall, within 10 days, unless otherwise provided, make the final inspection.

CONTROL OF MATERIAL

Samples and Tests. - Tests of all materials specified will be made by the engineer in accordance with the official approved methods described in the United States Department of Agriculture Bulletin No. 1216 Revised, so far as they apply. Whenever A.S.T.M. specifications and serial numbers are stipulated the reference shall be construed to be the specification and serial number of the American Society for Testing Materials, as amended to the date of the contract.

Storage of Materials. - Materials shall be stored so as to insure the preservation of their quality and fitness for the work.

Defective Materials. - All materials not conforming to the requirements of these specifications shall be considered as defective. No defective material, the defects of which have been subsequently corrected, shall be used until approval has been given. Upon failure on the part of the contractor to comply forthwith with any order of the engineer made under the provisions of this article, the engineer shall have authority to remove and replace defective material and to deduct the cost of removal and replacement from any moneys due or to become due the contractor.

LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

Laws to be Observed.- The contractor is assumed to be familiar with, and at all times shall observe and comply with, all Federal and State laws, and local by-laws, ordinances, and regulations in any manner affecting the conduct of the work.

Sanitary Provisions. - The contractor shall provide and maintain in a neat, sanitary condition such accomodations for the use of his employees as may be necessary to comply with the requirements and regulations of the State Department of Health or of other authorities having jurisdiction, and shall commit no public nuisance.

Public Convenience and Safety. - If the contractor constructs temporary bridges or provides temporary stream crossings, his responsibility for accidents shall include the roadway approaches as well as the structures of such crossings. Material stored upon the highway shall be placed so as to cause as little obstruction to the traveling public as is considered necessary. No road shall be closed by the contractor to the public except by express permission of the engineer.

Barricades, Danger, Warning, and Detour Signs. - The contractor shall provide, erect, and maintain all necessary barricades, suitable and sufficient red lights, danger signals and signs, provide a sufficient number of watchmen, and take all necessary precautions for the protection of the work and safety of the public. Highways closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. All barricades and obstructions shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise.

Use of Explosives. - When the use of explosives is necessary for the prosecution of the work, the contractor shall use the utmost care not to endanger life or property. All explosives shall be stored in a secure manner, in compliance with local laws and ordiances, and all such storage places shall be marked clearly "DANGEROUS - EXPLOSIVES".

Preservation and Restoration of Property, Trees, Monuments, etc. - The contractor shall be responsible for the preservation of all public and private property, trees, monuments, etc. along and adjacent to the roadway; shall use every precaution necessary to prevent damage or injury thereto; shall use suitable precaution necesaary to prevent damage to pipes, conduits, and other underground structures; and shall protect carefully from disturbance or damage all land monuments and property marks until an authorized agent has witnessed or otherwise referenced their location, and shall not remove them until directed. The contractor shall not injure or destroy trees or shrubs nor remove or cut them without proper authority. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof on the part of the contractor, such property shall be restored by the contractor and at the contractor's expense to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring same or he shall make good such damage or injury in an acceptable manner.

Responsibility for Damage Claims, etc. - The contractor shall save harmless the Government and all of its representatives from all suits, actions, or claims of any character brought on accounnt of any injuries or damages sustained by any person or property in consequence of any neglect in safeguarding the work or through the use of unacceptable materials in the construction of the improvement or on account of any act or omission, by the said contractor or his employees, or from any claims or amounts arising or recovered under the Workmen's Compensation Laws, or any other law, by-law, ordinance, order, or decree. The contractor shall be responsible for all damage or injury to property of any character during the prosecution of the work resulting from any act, omission, neglect, or misconduct, in the manner or method of executing said work satisfactorily or due to the non-execution of said work at any time due to defective work or materials and said responsibility shall continue until the roadway shall have been completed and accepted.

Contractor's Responsibility for Work. - Until the acceptance of the work by the engineer as evidenced in writing, the contractor shall have the charge and care thereof and shall take every necessary precaution against injury or damage to any part thereof by the action of the elements, or from any other cause, whether arising from the execution or from the non-execution of the work. The contractor shall rebuild, repair, restore and make good all injuries, damages to any portion of the work occasioned by any of the above causes before its completion and acceptance and shall bear the expense thereof, except damages to the work due to unforeseeable causes beyond the control of and without fault or negligence of the contractor, including but not restricted to acts of God or of the public enemy, acts of the Government, slides found by the engineer to have been unavoidable, and ordinary wear and tear on any section of the road opened to traffic by order of the engineer. In case of suspension of work from any cause whatever, the contractor shall be responsible for all materials and shall properly store them, if necessary, and shall provide suitable drainage of the roadway and erect temporary structures, where necessary

PROSECUTION AND PROGRESS

Subletting or Assigning of Contract. - The work awarded shall be performed by the contractor to whom the award is made, with the assistance of workmen under immediate superintendence, and the contract shall not be sublet, assigned, or otherwise disposed of, either in whole or in part, except with the written consent of the contracting officer.

Prosecution of Work. - The contractor shall notify the engineer at least 24 hours before beginning work; shall start the work at the point or points of the project designated by the engineer; and shall prosecute the work at as many different points as the engineer shall direct.

Limitations of Operations. - The contractor shall at all times conduct the work in such manner as will insure the least practicable interference with traffic and shall have due regard to convenient detours.

Forest Fires. - The contractor shall abide by such rules and instructions as to the time and place for burning and for fire control generally as the National Forest or Park Service officer may formally prescribe. Before setting any fires whatsoever the contractor will communicate with a responsible National Forest or Park Service officer for the area concerned. The contractor will take all necessary steps to prevent his employees from setting fires not required in the construction of the project and shall, under the direction of the appropriate National Forest or Park Service officer, or in the absence of any such officer, acting independently, extinguish such fires without expense to the United States. It shall be the responsibility of the contractor to prevent the escape of fires set in the construction of the project and to extinguish such as may escape, without expense to the United States. For the purpose of fighting forest fires in the vicinity of the right of way which are not caused by the contractor or his employees, the contractor when requested by the National Forest or Park Service officer, shall place his employees temporarily at the disposal of the appropriate Federal service; with the understanding, however, that payment to such employees for such services will be made by the United States at not less than the current rate for such services established by the Federal service in the area concerned, and any employees furnished will be relieved from fire fighting as soon as the National Forest or Park Service officer in charge finds that it is practicable to employ other labor adequate for the protection of the area. If the National Forest or Park Service officer is on the ground, the fighting of the fire will be under his direction.

During the period from April 1 to November 15 of each year spark arresters satisfactory to the National Forest supervisor or the National Park superintendent in charge of the area concerned shall be maintained on all steam machinery having a boiler and exhausting into the stack or using any form of forced draft.

Upon order of the engineer the contractor will be required to furnish a portable gasoline-driven pump and not less than 400 feet of 1½-inch hose and nozzle. The pump must have at least two cylinders and be capable of delivering 40 gallons per minute under a working pressure of 160 pounds per square inch.

When in the judgement of the National Forest supervisor, or National Park superintendent, brush should be burned only when a suitable pump and sufficient water are available, the engineer will require the contractor to suspend burning operations or to use such pump with water to extinguish all burning embers before they are left unattended and for any other protective purpose ordered.

Equipment. - The contractor shall furnish necessary and adequate equipment for the prosecution of the work in an acceptable manner and at a satisfactory rate of progress. Equipment used on any portion of the work shall be such that no injury to the roadway, adjacent property, or other highways will result from its use.

Use of Government Equipment. - Available Government road-building equipment may be used providing the contractor shall pay all of the costs of transferring the equipment from storage or warehouses of the Bureau of Public Roads to the project and its return to same storage or to another not more remotely located; employ competent operators; pay all maintenance and operating expenses of the equipment; pay a sum as agreed upon and return the equipment in as good condition as when received by the contractor, reasonable wear and tear excepted. No sum will accure for equipment placed in storage by the contractor when approved by the engineer.

Use of Government Explosives. - When explosives are furnished by the Government all expenses for demurrage, storage, handling, and hauling the explosives from the railroad siding or dock, as the case may be, to the project shall be borne by the contractor. Said explosives are to be received by the contractor and handled at his own risk subject to local laws and ordinances. The contractor shall prepare a schedule of his explosive requirements, in carload lots, which schedule shall allow at least 30 days' time for shipment of explosives by the Government. Shipments will be made in such quantities as the contractor may require for the efficient and economical conduct of the work. As payments become due the contractor under the terms of this contract, deductions shall be made for explosives furnished by the Government and used on the work. Upon the completion of the contract any surplus explosives remaining shall be returned to the Government at a point of storage on the project or to the railroad siding or dock specified, packed for shipment, as the engineer may direct. Any explosives lost or stolen while in charge of the contractor will be charged to the contractor and deductions therefor made from payments due the contractor.

The special provisions will so state whenever Government explosives are required to be used, and specify the price per pound at which Government explosives will be furnished.

Temporary Suspension of Work. - The contracting officer shall have the authority to suspend the work wholly or in part, for such period as he may deem necessary, due to unsuitable weather, or to such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as he may deem necessary due to the failure on the part of the contractor to carry out orders given, or to perform any provision of the contract. The contractor shall immediately respect the written order of the contracting officer to suspend the work wholly or in part.

The work shall be resumed when conditions are favorable or methods are corrected, as approved in writing by the contracting officer. The contractor shall not suspend the work without authority.

Termination of Contractor's Responsibility. - This contract will be considered complete when all work has been completed, the final inspection made, the work accepted by the engineer, and the final estimate paid. The contractor will then be released from further obligation except upon proof of error and as set forth in the performance bond.

MEASUREMENT AND PAYMENT

Measurement of Quantities. - All work completed under the contract shall be measured by the engineer according to United States standard measures, unless otherwise agreed upon in writing. All longitudinal measurements for area of pavement will be made along the actual surface of the roadway and not horizontally, and no deduction will be made for fixtures in the roadway having an area of 9 square feet or less.

Scope of Payments. - The quantities listed in the bid schedule are to be considered as approximate. Payments to the contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications and if, upon completion of the construction, these actual quantities shall show either an increase or decrease from the quantities given in the bid schedule the unit prices bid will still prevail except as otherwise specifically provided. Work and material that may be required under Articles 3, 4, and 5 of the contract (Standard Form No. 23) will be paid for at the contract unit prices bid for work and material of the same character, determined by the estimated cost of performance. If, however, such work and material increase or decrease the cost of performance, the unit price therefor may be agreed upon not exceeding the estimated cost thereof plus fifteen per cent. The contractor shall accept the compensation, as herein provided, in full payment for furnishing all materials, labor, tools, and equipment necessary to the completed work and for performing all work contemplated and embraced under the contract; also for all loss or damage arising from the nature of the work, or from the action of the elements, or from any unforseen difficulties which may be encountered during the prosecution of the work until its final acceptance by the engineer, and for all risks of every description connected with the prosecution of the work; also for all expenses incurred in consequence of the suspension or discontinuance of the work as herein specified. The payment of any current or final estimate or of any retained percentage shall in no way affect the obligation of the contractor to repair or renew any defective parts of the construction or to replace any defective materials used in the construction and to be responsible for all damage due to such defects, if such defects or damages are discovered on or before the final inspection and acceptance of the work.

Extra and Force-account Work. - Upon written order, work due to "changes" or to "changed conditions", or maintenance work required in maintaining traffic over "Accepted for Traffic" portions of the project or work of providing and maintaining detours, shall be performed on a force-account basis, as follows:

a. - For all labor, teams, and foremen in direct charge of the specific operation the contractor shall receive the current local rate of wage and the cost of the employers' liability insurance, to be agreed upon in writing before starting the work, to which shall be added an amount equal to 15 per cent of the sum thereof. No allowance shall be made for general superintendence and the use of small tools and ordinary equipment.

b. - For all materials used the contractor shall receive the actual cost of such materials, including transportation charges, as shown by original receipted bills, to which cost shall be added a sum equal to 15 per cent thereof.

c. - For any machine-power tools or special equipment, including pertinent fuel and lubricants, which it may be deemed necessary or desirable to use, the contracting officer shall allow the contractor a reasonable rental price to be agreed upon in writing before such work is begun for the time that such tools or equipment are in use on the work and to which sum no percentage shall be added.

The compensation as herein provided shall be received by the contractor as payment for extra work done on a force-account basis. The contractor's representative and the inspector shall compare records of extra work done on a force-account basis at the end of each day. Copies of these records shall be made upon suitable forms provided for this purpose, and signed by both the inspector and the contractor's representative, one copy being forwarded to the engineer and one to the contractor. All claims for extra work done on a force-account basis shall be submitted to the engineer by the contractor upon certified statements, and such statements shall be filed not later than the tenth day of the month following that in which the work was actually performed.

CONSTRUCTION DETAILS

EARTHWORK

CLEARING AND GRUBBING

Description. - Clearing and grubbing shall consist of clearing the ground of trees, brush, rotten wood, rubbish, and other objectionable material, as may be required within the areas designated by the engineer, including borrow pits, and of grubbing the roadway within the areas for grubbing, as designated by the engineer.

The right of way must be cleared on each side of the center line of the road to the full width indicated on the plans, or to a greater width if directed by the engineer. No trees, unless specifically designated, shall be cut down outside the limits of the roadway, except: (1) in clearing for borrow pits; (2) to let in sunlight on roads which are not to be surfaced; or (3) when needed visibility for motor vehicle drivers can not be secured by cutting off the lower branches of such trees. All trees left on the right of way shall be properly trimmed so as not to interfere with the vision of motor vehicle drivers. All stumps and all trees, the stumps of which are not to be grubbed, shall be cut not more than one foot or the diameter of the stump above the ground. From the area required for the roadway, except where the enbankment is to be three feet or more in height, all stumps, large roots and other embedded wood or vegetable matter, including duff, shall be grubbed or blasted from the ground and removed.

Timber cut from the right of way when through Government land may be made use of for constructing drainage or other structures and for camp purposes, provided proper authorization in writing is obtained from the Federal service responsible for the area within which the road is being constructed. In the event that timber for these purposes is not available on the right of way, the contractor may secure the necessary timber, if available, under proper authorization from the appropriate Federal service. Conditions covering the cutting and removal of timber and the disposal of brush and refuse will be contained in such authorization.

All timber which is to be cut shall be felled in the right of way, or as ordered in writing by the engineer. When required by the National Forest supervisor or National Park superintendent, merchantable portions of the trees to be cut shall be sawed into suitable log-lengths and piled along the right of way, separately from the piles to be burned, as directed. Any large logs and stumps which in the opinion of the National Forest supervisor or National Park superintendent can not be burned or advantageously piled need not be piled or burned; all other timber after felling and all other down timber, dead trees and stumps, together with all brush, roots, duff, rotten wood and other derbris shall be placed in piles ready for burning in such manner as to be completely consumed when the piles are burned. In case the burning is to precede the construction operations the piles may be placed in the center of the right of way; otherwise the piles shall be located in the most convenient place at the side of the right of way and beyond the fill slopes, where the burning will not cause damage to the surrounding forest cover.

All the piles, except those intended for merchantable lumber, shall be burned by the contractor, unless otherwise ordered by the engineer. All burning shall be done under the provisions hereinbefore given in the paragraphs on forest fires. In case burning is discontinued either for fire prevention or for other reasons, the contractor shall make such temporary disposal of the material on the ground as the engineer may indicate; any subsequent moving of the material by order of the engineer to complete the burning will be paid for as extra work.

Method of Measurement. - The area to be measured in payment for this item shall be that included within the limits as designated for clearing and as designated for grubbing.

Basis of payment. - The area measured as provided above shall be paid for at the prices per acre bid for "Clearing" and for "Grubbing", respectively, which prices will include all equipment, tools, labor, and incidentals necessary to complete the work.

ROADWAY AND DRAINAGE EXCAVATION

Description. - This item shall consist of excavating, sloping and shaping the roadway, removing and suitably disposing of all structures and materials taken from within the limits of the work, and shall include the constructing and finishing of the embankments, subgrade, shoulders, gutters, ditches, intersections, approaches and private entrances, all to the required alignment, grade, and cross section shown on the plans.

Classification. - All material excavated shall be unclassified and paid for as such, unless in the bid-form prices are asked and bid for solid-rock excavation and common excavation.

Unclassified excavation shall include all excavation performed under this item regardless of the material encountered.

Solid-rock excavation, when classification is provided for in the contract, shall consist of the removal and disposal of bowlders one-half cubic yard in volume or greater and of all hard rock found in place which, in the opinion of the engineer, can only be removed by blasting.

Common excavation, when classification is provided for in the contract, shall consist of all excavation found under this item not included in solid-rock excavation.

Construction Methods. - All suitable materials removed from the excavation shall be used as far as practicable in the formation of the enbankment, subgrade, shoulders, and at such other places as directed. No excavated material shall be wasted without written permission, and when such material is to be wasted it shall be disposed of as directed by the engineer. No payment will be made for any excavated material which is used for purposes other than those designated. During the construction of the roadway the roadbed shall be maintained in such a condition that it will be well drained at all times. Side ditches or gutters emptying from cuts to embankments shall be so constructed as to avoid damage to embankments.

Excavated rock shall be used in forming embankments wherever the depth of fill is sufficient to properly contain the rock removed by excavation, and shall be placed in accordance with directions given by the engineer. The engineer may permit the contractor to use excavated rock for purposes other than embankments, and in such case the contractor shall furnish and place, at his own expense, an amount of borrow equal to the deficiency caused by the rock being used elsewhere, if it is found necessary to borrow material to bring any part of the road to grade.

Ditches. - Ditches shall be interpreted to mean roadway ditches, changes in channels of streams, inlet and outlet ditches to culverts and other structures, and ditches parallel to or adjacent to the roadway, but beyond the limits of the roadway section as constructed, whether the excavation is dry or wet. The material excavated from all ditches and channel changes within 50 feet of the center line shall be used in the embankments when found suitable. No excavation or spoil from a ditch shall be deposited or left within 3 feet of the edge of the ditch unless otherwise shown on the plans or ordered in writing by the engineer. All roots, stumps, and other foreign matter in the sides and bottom of the ditch shall be cut to conform to the slope, grade, and shape of the section shown. The contractor shall maintain and keep open and free from leaves, sticks, and other debris all ditches dug by him until final acceptance of the contract.

Method of Measurement. - The yardage to be paid for shall be the yardage measured in its original position by the method of average end-areas, of material acceptably excavated as hereinabove prescribed. The material shall include overbreakage of slides in common excavation, not attributable to carelessness of the contractor, and authorized excavation of solid rock below grade, also of soft and spongy spots below grade. The measurement shall include unavoidable overbreakage in solid-rock excavation to an amount not to exceed in any half-station of 50 feet, 10 per cent of the actual quantity required for the same half-station within the lines shown on the plans.

Basis of Payment. - The yardage measured as provided above shall be paid for at the contract unit prices per cubic yard bid for "Unclassified Excavation", "Solid-Rock Excavation", or "Common Excavation", as the case may be, which prices shall be full compensation for the excavation, and also for the formation and the compaction of embankments, disposal of surplus structures and materials, preparation and completion of subgrade and shoulders, and the furnishing of all equipment, tools, labor, and incidentals necessary to complete the work.

EXCAVATION FOR STRUCTURES

Description. - This item shall consist of all excavation of foundations for culverts, bridges, and all other structures; this work shall include the disposal of all material obtained from such excavation and backfilling to the level of the original ground. It shall also include all necessary bailing, draining, sheeting, and the construction of cribs or cofferdams if found necessary. The material shall be disposed of in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

No allowances will be made for classification, regardless of the material encountered, unless required by the "Special Provisions".

Construction Methods. - The contractor shall notify the engineer a sufficient time in advance of the beginning of excavation for structures, so that the cross-sectional elevations and measurements may be taken of the existing ground and structure. Any materials removed or excavated before these measurements have been taken will not be paid for. The natural ground adjacent to the structure shall not be disturbed without permission of the engineer.

The foundation pits shall be excavated according to the outlines of the footings as shown on the plans and shall be of sufficient size to permit the placing of the full width and length of the footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only and the engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

All excavated material, so far as suitable, shall be utilized as backfill or embankment. The surplus material, whether or not temporarily allowed to be placed within the stream area, shall finally be disposed of in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure.

Bowlders, logs, or any other unforseen obstacles encountered in excavation shall be removed. All rock or other hard foundation material shall be freed from all loose material, cleaned and cut to a firm surface, either level, stepped, or serrated, as directed by the engineer. All seams or crevices shall be cleaned out and grouted. All loose and distegrated rock and thin strata shall be revoved. When masonry is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation and the final removal of the foundation material to grade shall not be made until just before the masonry is to be placed, except as hereinafter provided under foundation fills. Where foundation piles are used the excavation of each pit shall be completed before the piles are driven. After the driving is completed all loose and displaced material shall be removed, leaving a smooth solid bed to receive the masonry.

Cofferdams. - Suitable and practically watertight cofferdams shall be used wherever water-bearing strata are encountered above the elevation of the bottom of the excavation. Upon request the contractor shall submit drawings showing his proposed method of cofferdam construction and other pertinent features not shown in detail on the plans. Such drawings shall be approved by the engineer before construction is started, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement.

Cofferdams or cribs for foundation construction shall, in general, be carried well below the bottom of the footings and shall be well braced and as watertight as practicable. In general, the interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside of the forms. Cofferdams or cribs

which are tilted or moved laterally during the process of sinking shall be righted or enlarged so as to provide the necessary clearance and this shall be at the sole expense of the contractor.

When conditions are encountered which, in the opinion of the engineer, render it impracticable to unwater the foundation before placing masonry, he may require the construction of a concrete foundation seal of such dimensions as may be necessary, and of such thickness as to resist any possible uplift; concrete for such seal shall conform to all the requirements and specifications for "Concrete placed under water". The foundation shall then be pumped out and the balance of the masonry placed in the dry. When weighted cribs are employed and the weight utilized to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, special anchorage such as dowels or keys shall be provided to transfer the entire weight of the crib into the foundation seal. When a foundation seal is placed under water, the cofferdam shall be vented or ported at low-water level as directed.

Cofferdams shall be constructed so as to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing shall be left in cofferdams or cribs in such a way as to extend into the substructure masonry, without written permission from the engineer.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete, or for a period of at least 24 hours thereafter, unless it be done from a suitable sump separated from the concrete work by a watertight wall. Pumping to unwater a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

Unless otherwise provided, cofferdams or cribs with all sheeting and bracing shall be removed by the contractor after the completion of the substructure. The removal shall be effected in such a manner as not to disturb or mar the finished masonry.

Approval. - After each excavation is completed, the contractor shall notify the engineer, and no masonry shall be placed until after the engineer has approved the depth of the excavation and the character of the foundation material.

Backfilling. - After the structure has been completed, the areas around the foundations shall be filled with approved material, in layers, and compacted satisfactorily to the level of original surrounding surfaces. Materials which will not compact readily shall not be used in this work. When sufficient approved material is not available from the excavation, suitable additional material shall be obtained as borrow.

No backfilling shall be placed against any abutment, wingwall or culvert until permission shall have been given by the engineer. In the case of concrete or masonry such permission will preferably not be given until the masoney has been in place 21 days. Adequate provision shall be made for thorough drainage and drain shall be placed at weep holes.

Fill placed around culverts and piers shall be deposited on both sides to approximately the same elevation at the same time. All filling adjacent to structures shall be deposited in horizontal layers and well compacted. Especial care shall be taken to prevent any wedging action against the structure, and the slopes bounding the excavation shall be stepped or serrated to prevent such wedge action.

Method of Measurement. - The yardage to be paid for will be the yardage, measured in original position, of the material actually removed as hereinbefore prescribed, except that no yardage will be included of excavation outside of a volume bounded by vertical surfaces, 18 inches outside the neat footings and parallel thereto.

Basis of Payment. - The yardage measured as provided above shall be paid for at the contract unit price bid per cubic yard for "Unclassified Excavation for Structures", which price shall be full compensation for the excavating, for the backfilling, disposing of surplus materials, and for furnishing all material, labor, equipment, tools, and incidentals necessary to complete the work; provided that in the case of bridges when it is found necessary to carry footings more than 3 feet below the elevation shown on the plans, such excavation shall be paid for as provided in Articles 3, 4, and 5 of "Standard Contract Form No. 23" or as "Force Account".

FOUNDATION FILL

Description. - This item shall consist of rock or gravel backfill required to replace unsuitable foundation material below the foundation elevation for culverts, bridges and all other structures.

Material. - Foundation fill shall consist of suitably-graded gravel or rock as required by the engineer.

Construction Methods. - After the excavation has been completed as required by the engineer, the foundation fill shall be placed in uniform layers as directed to the foundation elevation and thoroughly compacted.

Measurement. - The yardage to be paid for will be the yardage measured in the final position, of the material actually placed as foundation fill except that no yardage will be included outside of the vertical planes limiting the payment for structure excavation.

Basis of Payment. - The yardage measured as provided above shall be paid for at the contract unit price bid per cubic yard for "Foundation Fill", which price shall be full compensation for excavating, hauling, depositing, and compacting the materials placed and for furnishing all material, labor, equipment, tools, and incidentals necessary to complete the work.

EMBANKMENT

Construction Methods. - Embankments shall be formed of suitable material. Where the method of construction will permit, the material shall be placed in successive layers and not more than 12 inches in depth for the full width of the cross section. Where rock is being used in the embankment, it shall be carefully distributed, and the interstices filled with earth to form a dense, compact mass. Written permission from the engineer must be secured before trestles may be used in the construction of embankments, and when trestles are so used and left in place they must be cut 2 feet below subgrade.

The contractor shall be responsible for the stability of all embankments made under the contract and shall bear the expense of replacing any portions which have become misplaced due to carelessness or negligent work on the part of the contractor or to damage resulting from natural causes, such as storms, cloudbursts, etc., not attributable, in the opinion of the engineer, to unavoidable movements of the natural ground upon which the embankment is made. Embankments over and around pipes, culverts, arches, and bridges shall be of selected materials placed and thoroughly tamped and compacted, as directed by the engineer, so as to avoid undue strain on the structure. Traffic over the work during construction shall be distributed so as to cover the entire surface.

The contractor shall construct embankments so that, after shrinkage and settlement are complete, all embankments shall have the required grade and cross section at all points.

Compensation. - Embankment will not be measured or paid for directly. It shall be considered a necessary part of the work paid for as unclassified excavation, common excavation, solid-rock excavation, excavation for structures, or borrow, as the case may be.

DISPOSAL OF SURPLUS MATERIAL

All surplus excavation and waste material shall be used to widen embankments uniformly or to flatten slopes, or shall be deposited in such other places and for such purposes as the engineer may direct. In no case shall material be deposited above the grade of the adjacent roadway unless directed in writing by the engineer. The contractor shall not borrow and waste without written application to and written consent from the engineer. Under no circumstances shall he be paid for excavation beyond the established line of the roadway prism, or for borrow, when such excavation or borrow results from the method of borrow and waste, nor for overhaul not actually required by the design. The work described under this item will not be measured or paid for direct. It shall be considered a necessary part of the work for unclassified excavation, solid-rock excavation, excavation for structures, or common excavation, as the case may be.

BORROW

Description. - This item shall consist of excavating, and disposing, as directed, of satisfactory material obtained from borrow pits designated, staked, and measured by the engineer. Borrow shall be used when sufficient quantities of suitable

materials are not available from the roadway and drainage excavation to properly form the embankments, subgrade, shoulders, and to complete the backfilling of structures. Where conditions are favorable, borrow pits in cuts to widen the inside of curves shall be designated by the engineer.

Classification. - No allowance will be made for classification, regardless of the material encountered.

Construction Methods. - The contractor shall notify the engineer sufficiently in advance of the opening of any borrow pit so that elevations and measurements of the existing ground surface may be taken. All borrow pits shall be neatly trimmed, and left in such shape as to admit of accurate measurement after the excavation is completed. Where practicable they shall be so excavated that no water will collect or stand therein.

Method of Measurement. - The yardage to be paid for under this item shall be the yardage, measured in its original position by the method of average end-areas, of material including over-burden or stripping acceptably excavated as hereinabove prescribed.

Basis of Payment. - The yardage measured as provided above shall be paid for at the contract unit price per cubic yard bid for "Unclassified Excavation for Borrow" which price shall be full compensation for the excavation and hauling, and also for formation and compaction of embankments, disposal of surplus material, and the furnishing of all equipment, tools, labor and incidentals necessary to complete the work.

OVERHAUL

When excavated or borrow material is hauled as directed more than 500 feet, overhaul will be allowed on such material. The overhaul distance will be the distance between the centers of volume of the material in its original position and after placing, less 500 feet. This distance shall be measured along the shortest practicable route. The number of station-yards of overhaul shall be the product of the volume of the overhauled material, measured in its original position, in cubic yards, by the overhaul distance in feet, divided by 100.

Basis of Payment. - Overhaul will be paid for at the unit price per station-yard bid for "Overhaul".

SUBGRADE

Description. - After the earthwork has been substantially completed and after all drains have been laid, the subgrade shall be brought to the lines, grades, and cross sections shown on the plans. Subgrade rolling will not be required unless prescribed in special provisions.

Construction Methods. - All soft and unstable material and other portions of the subgrade which will not compact readily shall be removed as directed. All bowlders appearing in the earth excavation shall be removed or broken off to a depth of not

less than 6 inches below the subgrade. All rock sections shall be brought to grade by depositing a satisfactory cushion material to the depth authorized by the engineer and all holes or depressions shall be filled with approved material and the subgrade brought to line and grade and compacted; this material shall be obtained as excavation or borrow and paid for as such unless otherwise directed in writing.

If the surface of an old stone or gravel roadbed conforms approximately to the surface of the finished subgrade at sections where reconstructed base course is not proposed, such sections shall be scarified superficially as directed to a uniform depth below and for the full width of the subgrade to a depth just sufficient to eliminate all depressions and to permit of uniform reshaping.

Highway Intersections. - All intersecting public highways shall be graded as shown on the plans or as directed by the engineer, and acceptable materials used on the surface so that a commodious, smooth-riding and satisfactory intersection shall be produced.

Railway Intersections. - At all grade crossings of intersecting railways the contractor shall construct the roadway so that a commodious, smooth-riding, and satisfactory intersection is obtained, meeting the requirements of the railway company. Four-inch planking for the full width of the roadway shall be securely spiked to the ties between the rails and on the extension of the ties outside the rails in such manner that the surface of the planking will coincide with the grade of the tops of rails.

Protection of Subgrade. - At all times ditches and drains along the subgrade shall be so maintained as to drain it effectively. When ruts of 2 inches or more in depth are formed, the subgrade shall be brought to grade, and if necessary be reshaped and rerolled. In no case shall any surface course or pavement be placed on a frozen or muddy subgrade. Storage or stock piling of materials on the subgrade will not be permitted. Until the subgrade has been checked and approved, no surface course or pavement shall be laid thereon.

Compensation. - Subgrade work shall not be measured and paid for directly but shall be considered as part of the work included in the unit prices bid for unclassified excavation, common excavation, solid-rock excavation, excavation for structures, or borrow.

SHOULDERS

Description. - After the earthwork has been substantially completed, and after all drains have been laid, the shoulders shall be constructed of approved material to the elevation and shape shown on the plans, and after the surface course or pavement is completed, dressed as directed to the full width of the roadbed.

Construction Methods. - Before any subgrade shall be approved the adjacent shoulders shall be constructed to the full width and at least to the level of the finished subgrade, but not necessarily to the final height and shape. In all cases

where subgrade rolling is required, it shall be extended onto the shoulders for a distance of at least 1 foot outside the pavement or surface course. At all times construction shall be so carried on that the subgrade, shoulders, and adjacent ditches will be effectively and completely drained. When the surface course or pavement is completed the shoulders shall be shaped and dressed, as directed, to the lines, elevations, and cross section shown on the plans. This work shall be done in proper sequence with the surface course, or pavement construction, as directed.

Compensation. - This work shall not be measured or paid for directly, but shall be considered as part of the work included in the unit prices bid for unclassified excavation, solid-rock excavation, excavation for structures, common excavation, or borrow.

SUBBASE

Description. - This item shall consist of special approved material placed and compacted when directed by the engineer in excavation made by the removal of soft, unstable, or other unsuitable subgrade materials and shall be constructed only where specifically directed and in accordance with these specifications.

Material. - The material to be used shall consist of sound, tough, durable telford stone, knapped field or quarry stone, crushed rock, slag, or gravel, and necessary filler. The telford stone shall be approximately 8 inches in depth; the field or quarry stones shall be not more than 5 inches in their largest dimensions after knapping; and the crushed rock, slag, or gravel shall consist of pieces varying from 1 inch to 3½ inches in diameter. When a finer material is necessary for the filler, quarry chips, gravel, or sand may be used to an amount not over 15 per cent of the total. All material shall be approved before being used.

Construction Methods. - Unsuitable subgrade materials shall be removed and the bottom of the excavation shaped uniformly and compacted firmly and provision made for drainage. The material shall then be placed in the prepared excavations. If telford stones are used, they shall be laid at right angles to the center line of the roadway and rammed in layers of not more than 8 inches in depth; or if knapped field or quarry stone, crushed rock, slag, or gravel is used, it shall be spread and rammed in layers of not more than 5 inches. After the material has been placed in layers until level with the surrounding subgrade surface the voids shall be filled with the finer material and the work rolled or tamped if inaccessible to the roller; and the filling and rolling shall be continued until the entire mass is compacted thoroughly and satisfactorily. The surface shall be finished to conform accurately to the grade and cross section of the surrounding subgrade.

Basis of Payment. - This work will be paid for at the contract unit price per cubic yard bid for "Subbase" complete in place, which price shall be full compensation for furnishing, hauling, and placing all materials and for all equipment, tools, labor, and incidentals necessary to complete the work.

FINISHING EARTH-GRADED ROADS

Description. - This item shall consist of the final finish ready for traffic of the roadbed where an earth-graded road without surfacing other than earth or selected material is proposed; the work shall consist of shaping and dressing the roadbed to conform to the lines, grades, and typical cross-section shown on the plans.

Construction Methods. - After all earthwork has been substantially completed all structures are complete, and all drains laid, the entire surface of the roadbed shall be scarified by a scarifying machine to a depth of 6 inches and shall then receive a finish shaping with a grading machine, supplemented by hand work where necessary to secure a smooth surface and a uniform cross section. All rock sections and all other sections where the natural material is not deemed suitable by the engineer shall be brought to grade by depositing to the depth authorized by the engineer, a satisfactory cushion of selected material. This material shall be obtained in excavation or borrow and paid for as such, together with the necessary overhaul on the same. The entire roadbed shall be brought to the final elevation and shape indicated on the plans and dressed as directed by the engineer. No roots, sod, or other deleterious matter, or stones that would fail to pass a 1½-inch ring shall be left within the top 4 inches of the finished road surface.

Basis of Payment. - Finishing work, including the full width of the roadbed as constructed, shall be paid for at the contract unit price per mile bid for "Finishing Earth-Graded Road", which price will include all equipment, tools, labor, and incidentals necessary to complete the work.

FINE-GRADING SUBGRADE AND SHOULDERS

Description. - This item shall consist of preparing a previously-graded road for immediate placement of surface courses or pavements. No work will be done or paid for under this item unless prices for same are requested in the bid schedule; otherwise all work described under this item shall be understood to be covered and compensated for as hereinbefore stated under roadway and drainage excavation, subgrade, and shoulders.

Construction Methods. - All slides shall be removed and the existing roadbed shall be scarified, if directed, bladed and shaped to conform accurately to the line, grade, and cross section shown on the plans. Should there develop any depressions or narrow embankments, sufficient approved earth material shall be obtained and placed, as common excavation, unclassified excavation, or borrow, to bring the surface of the roadbed, including the shoulders, to the exact lines, grades, and cross section shown on the plans. The roadbed shall then be rebladed and reshaped. The subgrade shall be compacted as provided in the specifications for subgrade, and all work done necessary to produce a completed and acceptable foundation for the placement of the surface course or pavement.

Method of Measurement. - The quantity of fine grading of subgrade and shoulders to be paid for shall be the number of miles of roadbed approved and completed, measured along the center line.

Basis of Payment. - The removal of all slides in excess of 5 cubic yards per station and furnishing and hauling the additional earth material mentioned above in excess of 5 cubic yards per station shall be paid for by the cubic yard at the unit prices bid for unclassified excavation, common excavation, or borrow. All other work covered by the specifications for this item shall be included in the price bid per mile for "Fine-Grading of Subgrade and Shoulders", which price shall be full compensation for shaping, dresssing, and compacting the subgrade and shoulders, all as prescribed in the specifications thereof, and for all equipment, tools, labor, and incidentals necessary to complete the work, provided further, whenever provision is not made in the proposal for the removal of slides, and furnishing and hauling additional earth material mentioned above, in excess of 5 cubic yards per station, then such work shall be paid for as extra work.

SURFACE COURSES

TWO-COURSE CRUSHED-ROCK OR CRUSHED-GRAVEL SURFACE-COURSE

Description. - This item shall consist of two courses, as indicated on the typical cross-section, composed of crusher-run stone or gravel, and binder, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross-section shown on the plans.

Material. - Crushed stone for this work shall be crushed from sound, tough, durable rock and shall be uniform in quality and well graded. Crushed gravel, when used, shall meet the above specifications.

Bottom-course material shall consist of crusher-run material passing a screen with circular openings of 1½ inches, and shall contain not more than 25 per cent of material passing a 1/4-inch opening, which fraction shall comply with the grading requirements for binder.

Top-course material shall consist of crusher-run material passing a screen with circular openings of 3/4 inch, and it shall contain not more than 35 per cent of material complying with the grading requirements for binder.

Binder shall consist of the finer products of the crusher, or sand, and of suitable clay or silt. Binder shall all pass a screen having 1/4-inch openings, at least 40 per cent shall be retained on a No. 30-mesh sieve, and 15 to 35 per cent of it shall pass a 200-mesh sieve.

Construction Methods. - In handling and placing all graded materials for this work, care shall be taken to prevent separation of the fine from the coarse materials and such separation shall be cause for rejection in the discretion of the engineer. In no case shall binder material be taken from embankments, shoulders, or slopes.

The bottom course shall be spread in a uniform layer on the prepared subgrade to such a depth that when compacted the compacted depth will be as shown on the plans. This work shall begin at the point nearest the source of supply. Where binder is required it shall be uniformly spread after a distance of approximately 2,000 feet of surfacing has been hauled and spread. The surfacing and binder shall then be thoroughly mixed by alternately blading the material into windrows in the middle, and back to the edges, of the subgrade until the material shall be uniform throughout. A heavy tightly-articulated grader with at least an 8-foot blade pulled by adequate mechanical power shall be used for this operation. When uniform the material shall again be carefully spread over the subgrade. Hauling shall be done over the surfacing material already deposited to compact it, accompanied by constant blading and dragging; care shall be taken to fill all ruts caused by hauling, to prevent formation of corrugations and waves in the longitudinal profile of the surface course, and to avoid segregation of the material into non-uniform layers or into patches of coarse or fine material. The hauling shall be distributed so far as practicable in order to produce uniform and thorough compaction of the surfacing material. During these operations whenever small areas lacking in binder, develop, binder shall be added

and evenly incorporated by blading or equivalent means, to produce a dense surface-metaling, complying with the grading requirements and completely bonded.

Watering. - During compaction water shall be applied as the engineer shall direct. The normal amount, unless otherwise directed, shall be a total of 60 gallons per cubic yard of materials.

Rolling. - When required, rolling shall be done with a roller of the self-propelled type, having a weight of at least 400 pounds per lineal inch of tire. A roller shall not be furnished on a project until authorized in writing. Rolling shall begin at the sides and progress toward the center line, overlapping at each succeeding passage.

When the bottom course is satisfactorily compacted, in the opinion of the engineer, the top-course material shall be similarly spread, watered, bonded, and compacted in two layers, and each layer treated as previously described. Supplemental crushed-rock shall meet the specifications for top course and will be deposited in piles along the roadway as directed by the engineer.

After the top course has been completed in the manner specified, the contractor shall shape and finish the entire roadbed, including gutters and shoulders, so as to produce a uniformly-crowned cross-section as shown on the plans and strictly conforming to the profile grade. The gutters shall be cleaned and all excess material, loose stones and rock fragments that may be dragged to the surface or loosened shall be deposited on the embankment slopes or as directed by the engineer. Until final acceptance the whole surface shall be bladed and dragged as often as necessary to assist in thorough compaction and to maintain it smooth and true to grade and cross sections.

Standard road planers, as shown on page 79 shall be used for performing the dragging required on this work and shall be left on the project upon the completion of the work. The cost of furnishing these planers will be considered as a part of the cost of surfacing and will be considered as covered by the bid prices for the respective items for this work.

Method of Measurement. - The yardage to be paid for shall be the yardage, measured in the vehicle, of bottom-course material and top-course material incorporated in the completed work and the yardage of supplemental material accepted in roadside piles; the yardage of binder to be paid for shall be the yardage, measured in the vehicle, hauled as directed more than 500 feet and incorporated in the work multiplied by the distance hauled expressed in miles or fractions of a mile less 500 feet. The measurement shall be at the point of delivery on the road. Binder found available within 500 feet shall not be measured for payment.

Basis of Payment. - The yardage determined as provided above, and the quantities actually furnished of the items enumerated below shall be paid for at the pertinent unit prices bid.

"Crushed-Rock or Crushed-Gravel Bottom-Course", per cubic yard.
"Crushed-Rock or Crushed-Gravel Top-Course", per cubic yard.
"Supplemental Crushed-Rock", per cubic yard.
"Supplemental Crushed-Gravel", per cubic yard.
"Binder hauled over 500 feet", per cubic yard-mile.
"Providing and maintaining water plant or plants on the job", a lump sum.
"Watering" as required, per 1,000 gallons.
"Providing and maintaining roller on the job", a lump sum.
"Operation of roller for days actually operated ,including operator, oil, gas, coal, etc.", per day.

Payment as prescribed above shall be full compensation for furnishing, hauling, and placing all material, and for all equipment, tools, labor, and incidentals necessary to complete the work.

ONE-COURSE CRUSHED-ROCK OR CRUSHED-GRAVEL SURFACE-COURSE

Description and Method of Construction. - This item is identical with two-course crushed-rock and crushed-gravel surface-course, save that it shall be constructed in one course and all work and material shall in all respects conform to that prescribed for the top course of the two-course item, which course shall be constructed on the prepared subgrade in accordance with the specifications and in conformity with the lines, grades, and cross sections shown on the plans.

Method of Measurement and Basis of Payment. - The method of measurement and basis of payment shall be as prescribed for the "Two-Course Crushed-Rock" or "Crushed-Gravel Surface-Course", save that the bottom-course price will not apply.

TWO-COURSE GRAVEL SURFACE-COURSE

Description and Method of Construction. - This item shall consist of work and material conforming to all the requirements for the work and material of the two-course crushed-rock or crushed-gravel surface-course, save that the material for gravel surface may be natural or uncrushed material. The finished work shall conform to the lines, grades, and cross sections shown on the plans.

Method of Measurement. - This work shall be measured as provided for the two-course crushed-rock or crushed-gravel surface-course.

Basis of Payment. - This work shall be paid for at the prices bid for the following items:

"Bottom Course of Gravel Surface-Course", per cubic yard
"Top Course of Gravel Surface-Course", per cubic yard
"Supplemental Gravel for Gravel Surface-Course", per cubic yard
"Binder hauled over 500 feet", per cubic yard-mile.

Watering and rolling and equipment therefor shall be paid for as prescribed under two-course crushed-rock or crushed-gravel surface-course.

STRUCTURES

CONCRETE BRIDGES

Description. - All concrete bridges shall be built as indicated on the plans, conforming to line, grade, and dimensions shown, and in accordance with the specifications for piling, concrete, reinforcing steel, and other items which constitute the complete structure.

Materials used shall be those prescribed for the several items which constitute the structure.

General Construction Methods. - All foundations shall be prepared as hereinbefore specified under excavation for structures, and they shall be inspected and approved by the engineer previous to placing any concrete. All foundations shall be poured in the "dry" except as provided for concrete seals or in the special provisions or upon written permission by the engineer.

Method of Measurement. - The quantities of the various pay items which constitute the completed and accepted structure will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

Basis of Payment. - The quantities measured, as provided above, will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing ,hauling, and placing all materials, and for all labor, equipment, tools, and necessary incidentals. Such payment shall constitute full payment for the completed structure, ready for use, and no additional allowance will be made for cofferdam construction, falsework, form lumber, or other erection expenses.

STEEL BRIDGES

Description. - All steel structures shall be built as indicated on the plans, conforming to line, grade, dimensions and design shown, and in accordance with the specifications for piling, concrete, masonry, structural steel and other items which are to constitute the complete structure and in conformity with such specifications prescribed under concrete bridges as are involved.

Materials. - The materials to be furnished and used shall be those prescribed for the several items which are to constitute the structure.

Paint Materials. - Steel structures shall be painted with three coats of paint, as follows:

1. - Shop coat. - Red-lead paint.

2. - First field-coat. - Red-lead paint, with or without tint of lamp black. (Alternate) - White-lead zinc-oxide paint (tinted light-gray with lamp black).

3. - Second field-coat. - Aluminum paint. - This paint shall be used only over the first field-coat of red lead.
(Alternate) - White-lead zinc-oxide paint (tinted light-gray with lamp black). This paint shall be used only over white-lead zinc-oxide paint (tinted light-gray with lamp black). The second field-coat shall be tinted to a different shade from that of the first field-coat.

Unless otherwise provided the paints shall consist of pigments of the required fineness and composition ground to the desired consistency in pure linseed oil in a suitable grinding-machine to which oil, thinner ,and drier shall be added. The oil, thinner, and drier shall meet the requirements of the Federal Specifications Board as given in master specifications numbered as follows:

a.- Linseed oil, raw : Master Specification No.4-b.
b.- Linseed oil, boiled: Master Specification No. 475-b.
c.- Turpentine: Master Specification No. 7-b.
d.- Mineral spirits: The volatile spirits for thinning paints shall conform to the requirements of the Master Specification No. 1C.
e.- Drier: Master Specification No. 20-a.

Lead Paints.- Red-lead paint, tinted and untinted, shall conform to Federal-Specifications-Board Specification No. 11, using 95-per cent true red lead (Pb_3O_4). For the first field -coat, the above red paint shall be tinted if required a light-brown color satisfactory to the purchaser by the addition of lamp-black paste in an amount not exceeding 1/4-pound per gallon of linseed oil. White-lead zinc-oxide paint, tinted and untinted, shall conform to Federal-Specifications-Board Specification No. 10-b and shall be tinted if required with lamp black to a gray color satisfactory to the purchaser. The lamp black shall conform to the requirements of the A.S.T.M. standard specifications for lamp black, Serial Designation D-209-26.

Aluminum Paint. - Aluminum paint shall have the following composition:

Aluminum powder	2.0 pounds
Spar varnish	1.0 gallon

The powder shall be mixed with the varnish in sufficient quantities only for each day's use. The paint shall be throughly mixed by vigorous stirring, and afterwards frequently stirred to retain the proper consistency. Ready-mixed aluminum paint shall not be used.

Aluminum Powder for Aluminum Paint.- The powder shall be furnished in one grade only and shall be made from metallic aluminum having a minimum aluminum content of 99 per cent. The powder shall be in the form of flakes, shall be polished and shall possess the property of "leafing" when suspended in varnish. It shall contain no adulterants such as mica. The powder shall all pass a 100-mesh standard-sieve and the acetone extract (16 hours) shall not exceed 3 per cent.

Sampling and Testing the Powder.- One 4-ounce sample shall be taken from each lot of 100 pounds or part thereof. Methods of testing the powder shall be as prescribed in paragraphs 1, 2, 3, 4, and 5 below.

1.- The physical condition of the flakes, such as shape, brightness, "leafing", etc., shall be determined by microscopic or other visual examination and by practical tests of the material when suspended in varnish.

2.- For the detection of adulterants such tests as may be deemed necessary shall be used.

3.- Fineness.- One ounce from each four-ounce sample of the powder shall be wet with alcohol and passed through a standard 100-mesh sieve.

4.- Acetone Extraction.- A flat-bottom alundum thimble, grade R-A-98 coarse, 30 millimeters wide and 80 millimeters high shall be used to hold the sample. To distribute the solvent and prevent splashing a circle of filter paper, which may have some fine perforations, shall be folded in capsule form to fit into the top of the thimble. The extractor used shall be the apparatus required in A.S.T.M. 1924 standards, Serial Designation D-38-24 (Figure 3, page 1044).

Place about 2 grams of the sample in the weighed thimble, taking care to avoid spreading over the sides. Reweigh to find the exact amount of sample taken. Insert the cover and put the thimble in position in the basket. Holding the thimble over the flask of the extractor (containing 25 cubic centimeters of redistilled acetone) pour another 25-cubic-centimeter portion of redistilled acetone into the thimble to wet the sample. Then put the apparatus in place for extracting. After the heating has become constant, adjust the distance between the lamp and flask so that condensed liquid is returned at a rate of about a drop per second. Continue for at least 16 hours. Transfer the liquid from the extractor flask to an evaporation container, previously dried and weighed. Rinse the flask 4 times with a fine stream of acetone, adding to the main portion of the extract. Evaporate the acetone from the extract at a gentle heat, finally drying for one-half hour at not over 105 degrees Centigrade. When completely dried, cool, weigh, and calculate the percentage of material extracted from the powder.

5.- Determination of Purity of Metallic Aluminum (by testing the powder).- The washed residue from the acetone test shall be analyzed for iron, silicon, copper, lead, and zinc. The sum of the iron, silicon, and copper shall not exceed one per cent. Lead and zinc shall be absent. Copper shall not exceed 0.2 per cent.

Spar Varnish for Aluminum Paint.- The spar mixing-varnish shall be of but one grade and shall have the following properties:

a.- The varnish shall be clear and transparent.

b.- The varnish shall contain not less than 50 per cent, by weight, of non-volatile oils and gums.

c.- For toughness the varnish shall pass a 60-per-cent Kauri reduction - test at 24°C.

d.- The varnish shall "set to touch" in not less than 2 hours nor more than 6 hours, and shall "dry hard" in not more than 24 hours.

e.- The varnish shall be of such consistency that when thoroughly mixed with aluminum powder, conforming to the specifications, in the proportion of 2 pounds of powder per gallon of varnish, the paint shall show satisfactory spreading qualities and shall not run or sag when applied to a vertical surface.

f.- The viscosity shall be not less than 0.50 nor more than 1.25 poises.

Sampling and Testing the Spar Varnish.- A thoroughly-representative sample of the varnish offered for delivery shall be selected by the inspector and forwarded to the laboratory for tests Nos. 1, 2, 3, 4, and 5 prescribed below.

1.- Appearance.- Pour some of the thoroughly-mixed sample into a clear-glass bottle or test tube and examine by transmitted light. The varnish shall be clear and transparent.

2.- Non-Volatile Matter.- Place a portion of the sample in a stoppered bottle or weighing pipette. Weigh container and sample. Transfer about 1.5 grams of the sample to a weighed, flat-bottomed metal dish about 8 cm. in diameter. Weigh container again and, by difference, calculate the exact weight of the portion of sample transferred to the weighed dish. Heat dish and contents in an oven maintained at 105° to 110°C. for 3 hours. Cool and weigh. From the weight of the residue left in the dish and weight of the sample taken, calculate the percentage of non-volatile residue.

3.- Kauri Reduction-Test for Toughness.- The toughness of the varnish is determined by the Kauri reduction-test, as follows: By proportionately reducing its toughness by the addition of a standard solution of "Run-Kauri" gum in pure spirits of turpentine and testing the reduced varnish on a tin panel. Upon bending the panel as prescribed below, the varnish shall show no cracking whatsoever at the point of bending.

a.- Preparation of the "Run-Kauri".- Arrange a distillation flask, water-cooled condenser, and a tared receiver on a balance. Place in the flask about one-third of its volumetric capacity of clear, bright, hard pieces of Kauri gum broken to pea size. Carefully melt and distill until 25 per cent, by weight, of the gum taken is collected in the tared receiver. Put the residue into a clean pan and when cold break up into small pieces.

b.- Preparation of Standard "Run-Kauri" Solution.- Place a quantity of the small broken pieces of "Run-Kauri" together with twice its weight of

freshly-distilled spirits of turpentine, using only that portion distilling over between 153° and 170°C. in a carefully-tared beaker. Dissolve by heating to a temperature of about 149°C. and bring back to correct weight, when cold, by the addition of the amount of redistilled spirits of turpentine necessary to replace the loss by evaporation during the dissolving of the gum.

c.- Reduction of the Varnish.- Having carefully determined the non-volatile content of the varnish as given in the previously described test for "Non-volatile matter", take 100 grams of the varnish and add to it an amount of the standard "Run-Kauri" solution equivalent to 60 per cent, by weight, of the non-volatile matter.

d.- Application of the Varnish.- Flow a coat of the varnish, thus reduced, on one of the tin panels described below and let stand in a nearly vertical position at room temperature for 1 hour. Next place the panel in a horizontal position in a properly-ventilated oven and bake for 5 hours at 95° to 100°C. Remove the panel from the oven and allow to cool at room temperature, preferably 24°C. for 15 minutes.

e.- Tin Panels.- The tin panels used in the tests shall all be cut from bright tin-plate weighing not more than 25 grams nor less than 19 grams per square decimeter (0.51 to 0.39 pound per square foot). (Commercial bright tin-plate about 0.0109 of an inch thick should weigh about 0.44 of a pound per square foot. It is important that the tin plate used shall be within the limits set.) The panels shall be about 3 by 5 inches and shall be thoroughly cleaned with benzol immediately before using.

f.- Bending the Panel.- Place the panel, with the varnished side uppermost, over a 3-millimeter (1/8-inch) rod, held firmly by suitable supports, at a point equally distant from the top and bottom edges of the panel, and bend the panel double rapidly. For accurate results, the bending of the panel should always be done at 24°C. for a lowering of the temperature will lower the percentage of reduction that the varnish will stand without cracking while an increase in the temperature increases the percentage of reduction that the varnish will stand.

4.- Test for Time Required to "Set to Touch" and "Dry Hard".- Pour the varnish on one of the tin panels described above. Place the panel in a nearly vertical position in a well-ventilated room but not in the direct rays of the sun. The atmosphere of this room must be free from products of combustion or laboratory fumes. The temperature of the room should be from 21° to 32°C. The film is tested at points not less than one inch from the edge of the film by touching lightly with the finger. The varnish is considered to have set to touch when gentle pressure of the finger

shows a "tacky" condition but none of the varnish adheres to the finger. The varnish is considered to have dried hard when the pressure that can be exerted between the thumb and finger does not move the film or leave a mark which remains noticeable after the spot is lightly polished. If rapid light-rubbing breaks the surface, the sample is considered not to have satisfactorily dried hard. In case the test shows the time of setting-to-touch or drying-hard to be other than prescribed above two additional tests shall be run on different days, and if the varnish does not meet the drying and hardening requirements on both of these additional tests it shall be considered unsatisfactory. In cases where different laboratories fail to agree on the drying time due to different atmospheric conditions, and umpire tests are necessary, such tests shall be made in a well-ventilated room maintained at a temperature of 21°C. and at a relative humidity of 65-per-cent saturation.

5.- Viscosity.- Determine the viscosity of the varnish by comparison at 25°C. with secondary standards whose viscosity, expressed in poises, has been accurately determined at that temperature. If Gardner-Holdt tubes (Circular No. 178, Paint Manufacturers Association of the United States) are used, the limits are tubes A to E inclusive.

Packing and Shipping Paint.- All paint furnished must be shipped in strong, substantial containers, plainly marked with the name, weight, and volume of the paint content, together with the color, formula, and name and address of manufacturer.

Unless otherwise specified, aluminum powder shall be packed in sealed cardboard cartons containing one pound each. Fifty such cartons shall be packed in a box made of at least 3/8-inch wood, planed on the outside. When specifically required, the powder shall be packed in friction-top cans containing 5 or 50 pounds each. In such cases the requisition will state whether or not the cans shall be boxed.

Cartons and boxes as well as unboxed cans shall be marked with the name of the manufacturer, name of powder, the quantity contained, and the contract or purchase-order number.

Unless otherwise specified, the varnish shall be delivered in one-gallon cans, packed in secure wooden cases. Cans shall be marked with the words "Spar mixing-varnish for aluminum paint". Cases shall be marked with the words "Spar mixing-varnish for aluminum paint", the quantity contained, the name of the contractor, and the number of the contract or order under which delivery is made.

Notes for purchasing officers, bidders and manufacturers.- Spar mixing-varnish for aluminum paint is especially designed for use in the preparation of aluminum paint. It is not intended for use as a clear varnish.

Varnish shall be measured by volume, the unit being a gallon of 231 cubic inches at 15.5°C. The volume may be determined by measure, or, in case of large deliveries, it may be determined from the net weight and specific gravity at 15.5/15.5°C. of the delivery.

Construction Methods. - The construction methods used shall be those prescribed for the several items which are to constitute the structure and in particular shall conform to the requirements for fabrication and erection, as hereinbelow prescribed under "Structural Steel". No compensation for fabrication or erection of steel superstructure or structural steel shall be allowed save as provided under "Structural Steel" hereinafter.

Paint. - Paint shall be applied only when the air temperature is at or above 40° F. It shall not be applied on damp surfaces or upon metal containing frost, nor shall it be applied when the air is misty, or otherwise in the opinion of the engineer unsatisfactory for work. In the application of aluminum paint by brushing, the finish strokes shall generally be made in the same direction. No direct compensation shall be allowed for the paint or for the application of the paint for steel bridges or structural steel. These features shall be considered as included in the price bid for "Structural Steel".

Method of Measurement. - The quantities of the various pay items, which constitute the completed and accepted structure shall be measured for payment according to the plans and specifications for the several pay items. Only accepted work will be included and the dimensions will be those on the plans or ordered in writing.

Basis of Payment. - The quantities, measured as provided above, shall be paid for at the contract unit prices bid for the several pay items, which payment and prices shall be full compensation for furnishing, preparing, fabricating, transporting, placing and erecting all materials for the complete structure, for all shop work, painting, and field work, for all labor, equipment, tools and incidentals necessary to complete the work. Such payment shall constitute full payment for the completed structure ready for use, and no allowance will be made for cofferdam construction, falsework, or other incidental expenses.

TIMBER STRUCTURES

Description. - This item shall consist of timber structures, except log structures, and shall be built as indicated on the plans, conforming to line, grade, and dimensions shown, and in accordance with the specifications for piles, concrete, untreated timber, treated timber, wearing top, and other items which constitute the complete structure.

Material. - (a) - All timber shall be of the species called for on the plans or in the "Special Provisions" and shall be graded in conformity to one of the following standard grading rules:

1. - American Lumber Standards, as contained in the Simplified Practice Recommendations No. 16 issued by the Bureau of Standards, United States Department of Commerce, dated 1926, as tentatively revised December 14, 1928.
2. - West Coast Lumbermen's Association, dated 1926.
3. - Southern Pine Association, dated 1927.

The individual pieces shall conform to the grading designation as noted in the following table:

Member	American Lumber Standards	West Coast Lumbermen's Association	Southern Pine Association
Columns and sills	Dense common	No. 1 common	Structural square edge and sound
Wheel guards) Bumpers) Bulkhead sheeting) Bracing)	No. 1 common	No. 1 common	Structural square edge and sound
Truss members) Floor beams)	Dense select (structural)	Dense select (structural)	Select (structural)
Stringers	Dense select (structural)	Dense select (structural)	Select (structural)
Caps - flooring	Select (structural)	Selected common	Dense heart
Rails and rail posts	Select	Selected common	Structural square edge and sound

(b)- All untreated timber shall show at least 85 per cent heart-wood on any girt.

(c)- Treated timber shall be interpreted to mean timber treated by a pressure method to retain the quantity of preservative per cubic foot as hereinafter specified and so treated that all sapwood is entirely impregnated with the preservative.

Preservative Treatment.- Timber to be treated for preservation shall be cut and framed, bored, and stringers sized prior to treatment.

In treating timbers the range of pressure, temperature, and time duration shall be controlled so as to result in maximum penetration by the quantity of preservative injected.

The treatment shall fulfill the following requirements:

For fresh-water use

Form of product	Minimum absorption	
	Douglas fir	Other species
	Pounds per cubic foot	
Piling	8 empty-cell 12 full-cell	8 empty-cell 16 full-cell
Structural timber of 5-inch thickness or more	8 empty-cell 12 full-cell	8 empty-cell 16 full-cell
Structural timber of less than 5-inch thickness	10 empty-cell 12 full-cell	10 empty-cell 16 full-cell

For salt-water use

Form of product	Minimum absorption	
	Douglas fir	Other species
	Pounds per cubic foot	
Round piling	12 full-cell	22 full-cell

Creosote of American Wood Preservers' Association, grades 1, 2, or 3, or creosote coal-tar solution will be satisfactory. Bidder must specify which grade he proposes to furnish

Where initials A. W. P. A. are used, the intent is to refer to the American Wood Preservers' Association.

Hardware.- Bolts shall be of the sizes specified and must be perfect in every respect. They shall have square or carriage heads and square or hexagonal nuts, and screw threads shall make close fits in the nuts. All bolts passing through non-resinous wood shall be galvanized or shall be painted with two coats of red lead.

When specified on the plans all hardware, including nails, spikes, nuts and washers shall be galvanized.

Bridge Iron.- Steel truss-rods, structural shapes, and plates shall conform to the requirements of the standard specifications for structural steel for bridges of the American Society for Testing Materials, (A.S.T.M.) Serial Designation A-7-24. No welds in truss rods will be permitted. All plates or shapes which are heated to facilitate bending shall be properly annealed. Steel castings shall conform to the requirements of the standard specifications for steel castings of the A.S.T.M., Serial Designation A-27-24, and shall be class-B medium grade. Iron castings shall conform to the requirements of the standard specifications for gray-iron castings of the A.S.T.M., Serial Designation A-48-18.

Construction Methods.- All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact-surfaces. Mortises shall be true to size for their full depth and tenons shall make snug fit therein. No shimming or blocking will be permitted in making joints, nor will open joints be accepted. Piles shall meet the requirements prescribed under the item "Piling".

In pile bents no shimming on tops of piles will be permitted. The piles for any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. Cutoffs shall be accurately made to insure perfect bearing between the caps and piles. Untreated timber used for mud sills shall be of cedar, heart cypress, redwood or other durable timber. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place. Concrete pedestals for the support of framed bents shall be carefully finished so that the sills or posts will take even bearing on them. Dowels of not less than 3/4-inch diameter and projecting at least 9 inches above the tops of the pedestals, shall be set in them when they are cast, for anchoring the sills or posts.. Sills shall have true and even bearing on mud sills, piles or pedestals. They shall be drift bolted to mud sills or piles with bolts of not less than 3/4-inch diameter and extending into the mud sills or piles at least 6 inches. When possible all earth shall be removed from contact with sills so that there will be free-air circulation around them.

Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends. All caps shall be secured by drift bolts of not less than 3/4-inch diameter extending at least 9 inches into the posts or piles. The drift bolts shall be approximately in the center of the post or pile.

Holes for round drift-bolts and dowels shall be bored with a bit 1/16-inch less in diameter than the bolt or dowel to be used. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel. Holes for machine bolts shall be bored with a bit of the same diameter as the bolt. Holes for rods shall be bored with a bit 1/16-inch greater in diameter than the rod.

Stringers shall be sized at bearings and shall be placed in position so that knots near the edges will be in the top portions of the stringers. Outside stringers may have butt joints but interior stringers shall be lapped to take bearing over the full width of floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least 1/2-inch for the circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are two panels in length the joints shall be staggered. Cross bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails at each end.

Roadway floors shall be of the strip or laminated type. Floor plank shall have a nominal thickness of 2 inches and the width shown on the plans. Unless otherwise specified, they shall be sized on one edge to a uniform width and shall not vary in thickness from end to end. Unless otherwise specified, planks shall be full length and no splicing will be allowed. Planks shall be laid with the surfaced-edge down and each 2-inch piece shall be toe-nailed to each alternate stringer with 20-penny nails. The nailing of successive planks shall be staggered so that the spacing of nails along each stringer shall be not less than 4 inches. In addition each piece shall be nailed horizontally to adjacent pieces with 40-penny nails at 18 inches center to center and staggered both horizontally and vertically with nails in adjacent pieces. All floors shall be cut to a straight line along the sides of the roadway.

Wheel guards shall be constructed as shown on the plans and shall be bolted to the outside stringers by 3/4-inch hook-bolts spaced not more than 5 feet center to center. All joints shall be lapped and a bolt shall pass through each lapped joint. When the wheel guard is not blocked up from the floor, drain holes shall be provided at such intervals as to adequately drain the roadway. They shall be provided with galvanized-iron lining and arranged so as to discharge free of the structure.

Railings shall be built as shown on the plans and shall be constructed in a workmanlike and substantial manner. All railing material shall be untreated and shall be surfaced on four sides. All rails shall be squarely butt-jointed at the posts and the rails shall break joints.

A washer of the size and type specified shall be used under all bolt heads or nuts which would otherwise come in contact with wood. Cast-iron washers shall

have a thickness equal to the diameter of the bolt, and a diameter of four times the thickness. For malleable or plate washers the diameters or side size of the square shall be equal to four times the diameter of the bolt, and the thickness of the washers shall be equal to half the diameter of the bolt. Cast-iron washers shall be used when the timber is in contact with the earth. All bolts shall be effectually checked after the nuts have been finally tightened.

Protecting and Painting Untreated Timbers.- In structures of untreated timber the following surfaces shall be thoroughly coated with two coats of hot creosote-oil before assembling: Ends, tops, and all contact surfaces of posts, sills, caps, floor beams and stringers; all ends, joints and contact surfaces of bracing and truss members. Timber bumpers, the back faces of bulkheads and all other timber which is to be in contact with earth shall be similarly treated.

Hand railing and posts shall be painted with three coats of approved white-paint as provided for in the provisions for "Wood Guardrail".

The heads of untreated piles shall be given one of the following treatments, as indicated on the plans or as directed in writing by the engineer:

1.- The sawed surface shall be thoroughly brush-coated with two applications of hot creosote-oil.

2.- The sawed surface shall be heavily coated with red-lead paint after which it shall be covered with cotton duck, of at least 8-ounce weight, which shall be folded down over the sides of the pile and firmly secured thereto with large-headed roofing-nails. The edges of the duck shall be trimmed to give a workmanlike appearance. The duck shall then be waterproofed by being thoroughly saturaged and coated with one or more applications of red-lead paint.

Handling and Protecting Treated Timber.- Treated timber shall be carefully handled without sudden dropping, breaking of outer fibres, bruising or penetrating the surface with tools. It shall be handled with rope slings. Cant dogs, peaveys, hooks or pike-poles shall not be used. In water infested by marine borers, cutting and boring below high-water shall be avoided.

All cuts in treated piles or timbers, and all abrasions after having been carefully trimmed, shall be coated with at least three applications of hot creosote-oil and covered with hot roofing-pitch.

Before driving bolts, hot creosote-oil shall be poured into all bolt holes in such a manner that the entire surface of the hole shall be thoroughly coated with the oil. Any unfilled holes, after being treated with creosote oil, shall be plugged with creosoted plugs.

Painting Bridge Iron.- Before assembling, all bridge-iron surfaces in contact with timber shall be given two coats of red-lead paint as specified for the shop coat in the provisions for steel bridges. After assembling, all exposed metal-surfaces shall be painted with one coat of red-lead shop-paint as above specified and two coats of approved field-paint.

All bolts shall be given two coats of red-lead shop-paint as above specified.

Method of Measurement.- The quantities to be paid for under this item shall be the number of timber-truss spans complete in place, the number of board feet of timber, complete in place, not included in the superstructure. A timber-truss span shall consist of the complete superstructure for any one span, and will be classified according to span opening. The quantities of any piling, concrete masonry, or any supplemental floor wearing-tops placed as shown on the plans and accepted will be measured as provided in appropriate specifications. Measurements of timber will be computed from the net dimensions shown on the plans, unless changes in such dimensions have been authorized in writing by the engineer. The dimensions on the plans shall be interpreted as standard sizes. The standard-size dimensions shall be used in the computations even though the actual size be scant in the amount provided below. The measurement of timber will include only such timber as is a part of the completed and accepted work, and will not include timber used for erection purposes, such as falsework, bracing, sheeting, etc.

Standard Size and Dressing.- Standard size shall be interpreted to mean that sawn rough timber shall not be over 1/4-inch scant from the actual size specified. For instance, a 12-inch by 12-inch timber shall measure not less than 11-3/4 inches by 11-3/4 inches. Standard size, dressed, shall be interpreted to mean that not more than 1/4-inch shall be allowed for dressing each surface. For instance, a standard 12-inch by 12-inch timber, dressed four sides, shall measure not less than 11-1/2 inches by 11-1/2 inches.

Basis of Payment.- The pertinent quantities, determined as provided above, shall be paid for at the contract unit prices for "Timber-Truss Spans Complete" of the several span openings, per thousand feet board measure for "Untreated Timber", or "Treated Timber", as the case may be, which prices shall be full compensation for all material, structural steel, steel or iron castings, hardware, drains, equipment, tools, labor, painting, preservative treatment, and all incidentals necessary to complete the structure ready for use, but shall not constitute payment for concrete masonry or piling which will be paid for as separate items: Provided further that supplementary floor wearing-tops other than timber shown on the plans will be paid for as provided in special provisions.

Timber bumpers at the ends of concrete spans or steel spans with concrete decks will not be paid for separately but will be included in the bid price for concrete and shall include all material, bolts, washers, painting, etc.

LOG BRIDGES AND TRESTLES

Description.- This item shall consist of log trusses and log trestles, built as indicated on the plans conforming in all respects to the line, grade, and dimensions shown and in accordance with these specifications.

Material.- The logs used in constructing log bridges shall be of the species specified on the plans, or if not therein specified, as required by the engineer. The logs may be obtained and the tops and branches of trees shall be disposed of as provided in the specifications for clearing and grubbing, as hereinbefore given.

The logs shall be straight, sound, out of wind, and free from defects of all kinds and shall be cut from live trees not less than 30 days in advance of use, but not exceeding 1 year, and be allowed to season with the bark on. Immediately before use in the work all bark shall be peeled and the logs trimmed smooth of all knots and projections.

Steel truss-rods, structural shapes and plates, steel and iron castings shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given.

All lumber for flooring, railings, etc., shall be of the kind and dimensions indicated on the plans and shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given.

The contractor shall furnish all necessary bolts, driftbolts, spikes, nails, and other material or hardware called for on the plans or in the specifications.

Construction Methods.- The contractor shall provide experienced workmen and ample and suitable equipment and tools for performing the work and shall follow only well-recognized methods in preparing the timber and framing and erecting the structure. Where concrete or masonry piers or abutments are called for on the plans, they shall be constructed in accordance with the requirements of the plans and of the specifications herein given for the particular kind of concrete or masonry called for, and be paid for as thereunder prescribed.

The provisions for preservative treatment, painting bridge iron and rail, and methods of construction as specified for timber structures, shall apply to log bridges and log trestles.

Basis of Payment.- Each log-truss span and log-trestle span complete with floor system will be paid for at the price or prices bid per "Log-Truss Span Complete", for the length or lengths as shown on the plans, which shall include all parts of the bridge, including caps but excepting abutments, piers, and timber bents. This price shall be full compensation for all materials, bridge iron, hardware, equipment, tools, labor, painting, preservative treatment and all incidentals necessary to complete the structure ready for use; provided, however, that supplementary floor wearing-tops shown on the plans will be paid for as provided in the special provisions attached hereto.

Log timber bents, including sills, columns, posts, and bracing, will be paid for at the contract unit price bid per lineal foot for "Logs in Log Bents" as shown on the plans. Any sawed timber used in bents shall be paid for at the unit bid price per lineal foot for logs. This price shall be full compensation for all materials, hardware, preservative treatment and painting, equipment, tools, labor, and incidentals required to construct and complete the bents in accordance with the plans and specifications. Sawed-timber cross-bracing will not be paid for separately and the price bid per lineal foot of log shall include this item.

LOG ABUTMENTS FOR BRIDGES

Log abutments for bridges will be built according to the specifications for log cribbing, and as shown on the plans, and will be paid for as log cribbing.

LOG CRIBBING

Description.- This item shall consist of log cribbing built as indicated on the plans, conforming in all respects to the line, grade, and dimensions shown, and in accordance with these specifications.

Material.- The contractor shall secure and prepare all necessary logs, timber, hardware, etc., under the conditions and as called for under the heading of material for log bridges.

Construction Methods.- The cribbing shall be supported on mudsills, with flattened lower surfaces placed as shown on the plans. All logs, including face logs, tie logs, mudsills, and anchor logs, shall be properly notched together and driftbelted, as shown on the plans. The ends of the logs and all cut surfaces shall be treated with preservative as hereinbefore specified for timber structures.

The minimum lengths and sizes of logs shall be as shown on the plans. Each course of logs shall break joint with the adjacent courses. The lengths of tie logs required for the proper support and anchorage of the cribbing shall be as determined by the engineer.

The face and tie logs are to be so notched together, and hewn if necessary, that the face logs will be in contact with each other throughout their entire length, except that in case a satisfactory rock-backing is placed against the face logs, the engineer may permit open spaces not exceeding 4 inches in width between the face logs. When permission to use such spaces is given, the rock back-fill shall be carefully placed, using the larger rocks adjacent to the logs and backing up with the smaller rocks in such manner that no material may escape or be washed out.

Method of Measurement.- Log cribbing shall be measured on the basis of square feet of exposed surface between lines of intersection of respective surfaces.

Basis of Payment.- Payment will be made at the unit price bid per square foot of "Crib Face" in place complete, which price shall include the furnishing and placing of transverse mudsills, tie logs, anchor logs, and driftbolts. Such unit bid price shall be full compensation for all materials, hardware, equipment, tools, labor and incidentals required for the construction of the cribbing complete.

LOG CULVERTS

Description.- This item shall consist of log culverts, built as indicated on the plans, conforming in all respects with the line, grade, and dimensions shown, and in accordance with these specifications.

Materials and methods of construction shall be as prescribed for log bridges and log cribbing.

Method of Measurement.- Log culverts shall be measured along the center line, and the over-all length of the top of the culvert shall be taken.

Basis of Payment.- Log culverts shall be paid for at the contract unit price bid per lineal foot of "Log Culvert" of the respective sizes as set forth in the proposal, which price shall be full compensation for all material, equipment, tools, labor, and incidentals necessary to complete the work.

Wings or end walls containing less than 50 square feet in area will not be paid for separately but will be included in the bid price per lineal foot of culvert. Wings or end wall having 50 square feet of area or more will be paid for as log cribbing.

CULVERTS AND RETAINING WALLS

Description.- All concrete and masonry culverts, all pipe culverts, end walls, and retaining walls shall be built as indicated on plans, conforming to line, grade, and dimensions shown and in accordance with the specifications for concrete, masonry, pipe, of the several varieties, and other items which are to constitute the complete structures.

General Construction Methods.- All foundations shall be prepared as hereinbefore specified under excavation for structures, and they shall be inspected and approved by the engineer previous to placing any masonry or footing.

When pipe is of the bell-and-spigot type, the bell end of the pipe shall be laid upgrade and all joints shall be made watertight with 1-to-2 Portland-cement mortar in accordance with the standards of the American Society for Testing Materials, Serial Designation D-58-24. In refilling the pipe trench the material for back fill shall be free from large stones for a depth of 9 inches above the pipe and shall be placed carefully under and around the pipe and tamped to give the pipe a uniform bearing throughout. The ends of all pipe culverts shall be protected by concrete or masonry end-walls unless otherwise shown on the plans or ordered by the engineer.

Method of Measurement.- The quantities of the various pay items which constitute the completed and accepted structures will be measured for payment according to the plans and specifications for the several items. Only accepted work will be included and the dimensions used will be those shown on the plans or ordered in writing.

Basis of Payment.- The measured quantities as provided above will be paid for at the contract unit prices bid for the several items, which prices shall be full compensation for furnishing, hauling, and placing all material, all labor, equipment, tools, and necessary incidentals. Such payment shall constitute full payment for the completed structure ready for use.

CONCRETE

Description.- This item shall consist of concrete masonry composed of approved Portland cement, fine aggregate, coarse aggregate, and water, each measured separately and incorporated in accordance with the method and design prescribed for the several classes of concrete hereinafter designated as Classes A, B, and C, and shall be prepared and constructed in accordance with these specifications, where and of the form, dimensions, and class shown on the plans or directed in writing by the engineer.

Classification and Proportions.- The concrete shall be classified according to the proportions by dry volume of the cement, fine aggregate, and coarse aggregate, which shall be as shown in the following table. The ratio of fine to coarse aggregate specified for each class of concrete may be varied slightly by the engineer to obtain concrete of maximum strength and density, but the proportion of cement to the sum of the aggregates, measured separately, shall not be changed.

Class	Cement	Fine aggregate	Coarse aggregate	Minimum cement per cubic yard of concrete
	Bags	Cubic feet	Cubic feet	Bags
A	1	2	3	6½
B	1	2	4	5½
C	1	2½	5	4½

The class required for each part of the structure will be as follows, unless otherwise shown on the plans:

Class-A concrete shall be used for railings, concrete pipe, bridge slabs, beams, girders, and curbs.

Class-B concrete shall be used for all reinforced concrete, except as provided above, and for concrete deposited in water.

Class-C concrete shall be used for plain concrete, except concrete deposited in water.

Materials.- Portland Cement.- The cement used for this work shall be a standard brand of Portland cement and shall conform to the requirements and tests as provided in the United States Government Master Specification No. 1-a (Bureau of Standards Circular No. 33) Rev. June, 1927.

Water.- All water used in concrete shall be subject to the approval of the engineer, and shall be reasonably clear and free from oil, acid, or alkali and

vegetable substances, and shall not be brackish nor salty. Water of doubtful quality shall be tested in briquettes as prescribed in the Ottawa sand-mortar test, and the strength of such briquettes shall be equal to similar briquettes made of water of known satisfactory quality.

Fine Aggregate for Concrete.- The fine aggregate for concrete shall consist of sand or a combination of sand and stone screenings conforming to the following requirements.

Sand shall consist of clean, hard, durable, uncoated particles, free from lumps of clay, soft or flaky material, loam and organic matter. Sand for reinforced concrete shall be free from salt and alkali.

Stone screenings either alone or in combination with sand shall not be used as fine aggregate except by written permission of the engineer.

Screenings, when used, shall consist of particles resulting from the crushing of clean, tough, durable rock having a percentage of wear of not more than 6 per cent. Screenings for reinforced concrete shall be free from salt and alkali.

Fine aggregate shall be uniformly graded from coarse to fine, and when tested by laboratory methods shall meet the following requirements:

Sieve	Per cent
Passing 3/8-inch	100
Do. No. 4	85 to 100
Do. No. 16	65 to 90
Do. No. 30	30 to 50
Do. No. 50	5 to 25
Do. No. 100	0 to 10

Fine aggregate shall contain not more than 3 per cent of clay and inorganic silt by actual dry-weight.

All fine aggregate shall be free from injurious organic impurities. Aggregates subjected to the color test for organic impurities and producing a color in the sodium-hydroxide solution darker than the standard color shall be rejected unless subsequent mortar-strength or concrete strength-tests indicate them to be suitable for use.

Fine aggregate, when subjected to the mortar strength-test, shall have a tensile or compressive strength, at the age of 7 days and 28 days, of not less than 100 per cent of that developed by mortar of the same proportions and consistency, made of the same cement and standard Ottawa sand.

Coarse Aggregate.- The coarse aggregate for all classes of concrete shall consist of broken stone, gravel or slag, all conforming to the respective requirements following. Slag shall not be used in reinforced concrete.

Broken Stone.- The broken stone shall consist of uncoated particles of clean, hard, tough, durable rock. It shall contain no organic or other deleterious matter and shall be free from lumps of clay and soft pieces.

At least 95 per cent of the stone shall come from ledges conforming to the following requirements:

Per cent of wear, not more than ----- 7

The broken stone shall show no evidence of disintegration when subjected to 5 alternations in the sodium-sulphate test for soundness.

Gravel shall consist of clean, hard, and uncoated pebbles of high resistance to abrasion, having a per cent of wear of not more than 20 (gravel test). Gravel for reinforced concrete shall be free from salt and alkali.

Slag.- The broken slag shall be air-cooled blast-furnace slag and shall consist of angular fragments reasonably uniform in density and quality, and reasonably free from thin, elongated or glassy pieces, dirt or other objectionable matter.

The slag shall conform to the following requirements:

Per cent of wear, not more than ------- 15
Weight per cubic foot, not less than - 75 lbs.

Coarse aggregate shall be well graded from the maximum size to pieces one-quarter inch in diameter. The maximum size will generally be given on the plans, but if not given the following shall govern:

For Class-A concrete, the aggregate shall meet the requirements for Class-B concrete hereinafter given, except that for the railings and concrete pipe the aggregate shall all pass a screen having circular openings 3/4 of an inch in diameter. For Class-B concrete the aggregate shall have a maximum size not greater than will pass a screen having circular openings 1-1/2 inches in diameter, except that for walls and slabs less than 8 inches thick the aggregate shall have a maximum size not greater than will pass a screen having circular openings 1 inch in diameter; for Class-C concrete the aggregate shall have a maximum size not greater than will pass a screen having circular openings 3 inches in diameter.

When tested by means of laboratory screens with square openings, coarse aggregate shall meet the following requirements:

Amount of coarse aggregate passing the various laboratory screens

Maximum size of aggregate	3 inch	2-1/2 inch	2 inch	1-1/2 inch	1 inch	3/4 inch	3/8 inch	Passing No. 4 not more than
Inches	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
3	100	---	---	40-75	---	---	---	5
2-1/2	---	100	---	---	---	---	---	5
2	---	---	100	---	40-75	---	---	5
1-1/2	---	---	---	100	---	40-75	---	5
1-1/4	---	---	---	---	---	---	35-70	5
1	---	---	---	---	100	---	40-75	5
3/4	---	---	---	---	---	100	---	5

Rubble one-man stone may be embedded in Class-C concrete when shown on the plans or if permitted in writing by the engineer when the concrete is a non-reinforced mass of more than 2 feet in thickness. These stones shall not be placed within 6 inches of any finished surface of the concrete and shall be placed at least 6 inches apart. The stone for this purpose shall consist of clean, sound rubble stone, free from structural defects, foreign substances, and coatings of any character, shall be laid on their natural bed, and shall be washed and of a quality satisfactory to the engineer.

Construction Methods.- Falsework shall be built on good, firm foundation and be of sufficient strength to carry the loads without appreciable deformation. For single spans it shall be constructed with 1/20-inch camber for each foot of span, and for multiple spans it shall be constructed with 1/30-inch camber for each foot of span. If appreciable settlement occurs in the falsework, the engineer shall stop the work and require a thorough remodeling to insure a first-class product. In long spans, the engineer may require the contractor to use wedges to take up any slight settlement in the form work either before or during the placing of the concrete.

For continuous girders and arches, detail drawings of the falsework shall be submitted to the engineer for approval, but such approval shall not operate to relieve the contractor of any of his responsibility under the contract for the successful completion of the improvement. Arch centering shall be so constructed as to permit of its being gradually and uniformly lowered or released after pouring the arch ribs.

Forms shall be so designated and constructed that they may be removed without injuring the concrete.

The material to be used in the forms for exposed surfaces shall be sized-and-dressed tongue-and-groove or shiplap lumber or metal in which all bolt and rivet heads are countersunk, so that in either case a plain smooth surface of the desired contour is obtained. Undressed lumber may be used for backing or for surfaces which will not be exposed in the finished structure. The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar-tight and shall be thoroughly soaked with water before and throughout the pouring of concrete. Forms for reentrant angles shall be chamfered and for edges shall be filleted. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled or greased to insure the non-adhesion of mortar. Form lumber if used a second time shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete, any bulging or warping shall be remedied, and all dirt, sawdust, shavings, or other debris within the forms shall be removed.

Measurement.- Volumetric Batching.- The cement shall be measured as packed by the manufacturer, a sack containing not less than 94 pounds net being considered 1 cubic foot. When broken bags of cement are used, the cement for each batch shall be accurately measured. Fine and coarse aggregate shall be measured loose. The

contractor shall furnish and use an approved water-measuring-and-discharging device, also boxes or pans of such dimensions as will give, when filled and struck, the exact volume of aggregate required for the class of concrete specified.

Except as otherwise ordered sufficient water shall be used in mixing plain concrete to produce a mixture which will flatten and quake when deposited in place, but not enough to cause it to flow; and in mixing concrete in which reinforcement is to be embedded, sufficient water shall be used to produce a mixture which will flow sluggishly when worked and which at the same time can be conveyed from the mixer to the forms without separation of the coarse aggregate or water from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms, and the quantity shall be changed whenever and as ordered by the engineer.

A mixture shall be used which contains the minimum amount of water consistent with the required workability. If required by the engineer, the consistency of the concrete shall be measured by the slump test in accordance with the methods described in the A.S.T.M. Serial Designation D-138-26-T. Concrete subjected to this test shall be taken from that in place in the forms and the slump for the different types of concrete shall not be greater than as follows:

Mass concrete..... 3 inches

Reinforced concrete:

a.- Heavy or medium sections, including slabs, curbs, beams, girders, columns, walls, etc., where tamping and spudding can be readily done..... 3 inches

b.- Medium or light sections, including columns, piers, walls, etc., where tamping and spudding are difficult..... 5 inches

The concrete shall be mixed in the quantities required for immediate use, and any which has developed initial set, or which is not in place in the forms within 30 minutes after the water has been added, shall not be used. No retempering will be allowed. No concrete shall be mixed or placed while the air temperature is at or below 35° F. without the written approval of the engineer, and only when adequate means are employed to heat the aggregates and water. In general, the temperature of the mixed concrete shall not be less than 60°F. at the time of placing in the forms.

Unless hand mixing is specifically permitted by the engineer, the mixing shall be done in a batch mixer of approved type which will insure the uniform distribution of the materials throughout the mass so that the mixture is uniform in color and smooth in appearance. The mixing shall continue for a minimum time of one and one half minutes after all the ingredients including water are assembled in the drum, during which time the drum shall revolve at the speed for which it was designed, but shall make not less than 14 nor more than 20 revolutions per minute. The mixer shall be equipped with an attachment for satisfactorily locking the discharging device so as to prevent the emptying of the mixer until all the materials have been mixed for the minimum time required. The entire contents of the drum shall be dis-

charged before any materials are placed therein for the succeeding batch.

The size of batch and the total volume of all materials mixed per batch shall not exceed the rated capacity of the mixer as set forth in the following tables. The capacity of other mixers not shown in the tables shall be subject to the approval of the engineer.

Concrete		Size of batch in bags of cement per machine			
Class	Approximate mix	No. 3-1/2-S	No. 5-S	No. 7-S	No. 14-S
		Bag	Bag	Bag	Bags
A	1:2:3	1/2	1	1	3
B	1:2:4	1/2	1	1	3
C	1:2-1/2:5	1/2	1/2	1	2

Concrete		Size of batch in cubic feet of mixture per machine			
Class	Approximate mix	No. 3-1/2-S	No. 5-S	No. 7-S	No. 14-S
		Cubic feet	Cubic feet	Cubic feet	Cubic feet
A	1:2:3	1.95	3.89	3.89	11.67
B	1:2:4	2.26	4.52	4.52	13.56
C	1:2-1/2:5	2.74	2.74	5.47	10.94

When hand mixing is permitted, it shall be done on a water-tight platform. The fine aggregate and cement shall first be mixed until a uniform color is attained and then spread over the mixing board in a thin layer. The coarse aggregate, which shall have been previously drenched, shall then be spread over the fine aggregate and the cement in a uniform layer and the whole mass turned as the water is added. After the water has been added, the whole mass shall be turned at least six times, and until the mixture is uniform in color and smooth in appearance. Hand-mixed batches shall not exceed 1/2 cubic yard in volume.

Concrete shall be placed in the forms immediately after mixing in horizontal layers not over 12 inches in depth. It shall be so deposited that the aggregates are not separated. Dropping the concrete any considerable distance, depositing large quantities at any point and running or working it along the forms, or any other practice tending to cause segregation of the ingredients will not be allowed. It shall be compacted by continuous tamping, spading, or slicing. Care shall be taken to fill every part of the forms, to work the coarser aggregate back from the face, and to force the concrete under and around the reinforcement without displacing it. Mass concrete shall be deposited in continuous horizontal layers, and whenever practicable, all concrete in structures shall be deposited continuously for each monolithic section of the work.

Concrete shall be deposited in water only with the permission of the engineer and under his supervision. When depositing in water is allowed, the concrete shall be carefully placed in the space in which it is to remain in a compact mass by means of a tremie, bottom-dumping bucket, or other approved method that does not permit the concrete to fall through the water without adequate protection. The concrete shall not be disturbed after being deposited. No concrete shall be placed in running water, and forms which are not reasonably water-tight shall not be used for holding concrete deposited under water.

All bolts necessary to secure timber bumpers at the ends of concrete spans shall be set in the concrete as shown on the plans at the time of pouring the concrete deck.

Construction Joints.- Whenever the work of placing concrete is delayed until the concrete shall have taken its initial set, the point of stopping shall be deemed a construction joint. So far as possible the location of construction joints shall be planned in advance and the placing of concrete carried continuously from joint to joint. These joints shall be perpendicular to the principal lines of stress and in general be located at points of minimum shear. No joints shall be made with the concrete sloping to a thin edge. Bulkheads shall be used in all joints other than horizontal.

Where dowels, reinforcing bars, or other adequate ties are not shown on the plans, keys shall be made as directed by the engineer by embedding in the soft concrete water-soaked beveled timbers which shall be removed when the concrete has set. In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, laitance, or other soft material, with stiff-wire brushes, and, if necessary, shall be roughened with a steel tool. The surface then shall be thoroughly washed with clean water and painted with a thin coat of neat cement-mortar.

No concrete work shall be stopped or temporarily discontinued within 18 inches of the top of any finished surface, unless such work is finished with a coping having a thickness less than 18 inches, in which case the joint shall be made at the under line of the coping.

Expansion Joints.- Expansion and contraction of concrete structures shall be provided for by expansion joints as shown on the plans. Care should be taken in construction that these joints are so made as to permit a free movement at the joint when the concrete expands or contracts.

Curing Concrete.- Handrails, floors, and troweled surfaces shall be protected from the sun, and in drying weather the whole structure shall be kept wet for a period of 10 days. For concrete requiring finishing, the surface shall be kept moist until finishing is complete. Concrete floor-slabs shall be covered with damp sand as soon as the concrete has taken hard set and then kept wet for 10 days. The covering material shall not be cleared from the surface of the floor for a period of 21 days, during which time no traffic shall pass over the structure. Other precautions to insure thorough curing of the concrete shall be taken by the contractor as directed by the engineer.

During freezing weather the concrete shall be thoroughly protected until set, and, if required by the engineer, provisions for heating the concrete shall be provided in such a way that the air surrounding the fresh concrete will be kept at a temperature about 50°F. for a period of five days after the concrete is placed. Concrete placed under these conditions will not be accepted until after 30 consecutive days during which the temperature does not fall below 40°F.

Removal of Forms.- In order to make possible the obtaining of a satisfactory surface finish, forms on ornamental work, railings, parapets, and exposed vertical surfaces shall be removed in not less than 12 nor more than 48 hours, depending upon weather conditions. Forms under slabs, beams, girders, and arches shall remain in place at least 21 days in warm weather, and in cold weather at the discretion of the engineer. Forms shall always be removed from columns before removing shoring from beneath beams and girders, in order to determine the condition of concrete in the columns.

No forms whatever shall be removed at any time without the consent of the engineer. Such consent shall not relieve the contractor of responsibility for the safety of the work. As soon as the forms are removed all bolts, wires, or other appliances which hold the forms and which pass through the concrete shall be cut off or set back 1/2-inch below the surface in such a manner as not to disturb the concrete more than 1/4-inch around the hole. Lips of mortar and all irregularities caused by form joints shall be removed. The presence of excessive honeycomb-areas may be considered sufficient cause for the rejection of the structure, and upon written notice from the engineer the contractor shall remove and rebuild the structure in part or in whole as specified, at his own expense. In patching holes or porous spots, all coarse or broken material shall be chipped away until a dense uniform surface of concrete exposing solid coarse-aggregate is obtained. Feathered edges shall be cut away to form a face perpendicular to the surface being patched. All surfaces of the cavity shall be thoroughly saturated with water, after which a thin layer of neat cement-mortar shall be applied. The cavity shall then be filled

with a thick, dry mortar composed of one part of Portland cement to two parts of sand which shall be thoroughly tamped into place. The surface of this mortar shall be floated with a wooden float before initial set takes place, and shall present a neat and workmanlike appearance. The patch shall be kept wet for a period of 5 days.

For patching large or deep areas, coarse aggregate shall be added to the patching material if ordered by the engineer, and special precautions shall be taken to insure a dense, well-bonded and properly-cured patch, as required by the engineer.

Finishing Concrete.- All concrete surfaces shall be reasonably true and even, free from stone pockets, excessive depressions or projections beyond the surface. Concrete floors shall be struck off with a templet immediately after pouring to provide the proper crown, and shall be hand finished to a smooth even surface by means of both longitudinal and transverse wooden-floats, or other suitable means. The finished surface shall not show a variation of over 1/4-inch in 10 feet using a 10-foot straight-edge placed parallel to the center line of roadway, and no variations will be permitted that will tend to prevent complete drainage on all parts of the deck. The concrete bridge-seats and tops of walls and curbs shall be brought flush with the finished top-surface and struck off with a straight-edge and floated. All exposed surfaces which shall include bottom of overhung or cantilever portions of slabs, bottom, and outside of exterior beams or girders, faces of abutments, piers, or walls above a point 1 foot below the ground or fill line and all sides of curbs, handrails, columns, arch ribs, and struts, shall be finished by rubbing with a carborundum stone, except that when the forms can be removed while the concrete is still green, the concrete may be finished by floating with a wooden float. When a carborundum stone is used, a thin rich grout composed of fine sand and cement shall be spread over a small area of the surface and immediately followed by rubbing with the stone. The surface shall be finished so that all irregularities and form marks are removed, leaving a smooth uniform surface. A cement wash or plaster coat shall not be used.

Method of Measurement.- The yardage to be paid for shall be the number of cubic yards of concrete of the several classes, complete in place and accepted. In computing the concrete yardage for payment, the dimensions used shall be those shown on plans or ordered in writing by the engineer. No measurements or other allowances will be made for work or material for forms, falsework, cofferdams, pumping, bracing, etc.

Basis of Payment.- The yardage, determined as provided above, shall be paid for at the contract unit price bid per cubic yard for "Class-A, Class-B, or Class-C Concrete" as the case may be; such payment shall be full compensation for the concrete, all materials, timber bumpers, drains except for decks of steel spans, water stops; expansion-joint angles including bolts, and forms, falsework, placing and finishing, all equipment, tools, labor and incidentals necessary to complete this item, but shall not constitute payment for reinforcing steel which will be paid for as a separate item.

REINFORCING STEEL

Description.- This item shall consist of furnishing, and placing in concrete, reinforcing steel of the quality, type, size and quantity designated, all as required by these specifications and as shown on the plans. When deformed bars are specified, the form of the bars used must be approved by the engineer and shall be such as to provide a net section at all points equivalent to that of a plain square or round bar of equal nominal size. The use of cold-twisted bars will not be permitted. Steel mesh and expanded metal shall only be used when specified and shall be of the type shown on plans and approved by the engineer.

Material.- Reinforcing bars shall meet the requirements of the standard specifications for billet-steel concrete-reinforcement bars of structural or intermediate grade, Serial Designation A-15-14, or rail-steel concrete-reinforcement bars, Serial Designation A-16-14, of the American Society for Testing Materials, provided the last named bars are not rolled by the "piling" method and provided they are shop bent.

If purchased from warehouse in small lots, reinforcement may, at the direction of the engineer, be accepted subject to the bending test.

Steel-wire reinforcement to be used as such or in fabricated form shall conform to the requirements of the A.S.T.M. tentative standard specifications A-82-27-T, as amended to date of contract. Wire, wire mesh, and expanded metal, when used for concrete reinforcement shall be of a type and quality approved by the engineer.

Construction methods.- When placed all reinforcement shall be free from dirt, oil, paint, grease, mill scale, loose or thick rust.

When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected. All reinforcement shall be placed in the exact position shown on the plans, and shall be so securely held in position by wiring and blocking from the forms and by wiring together at intersections that it will not be displaced during the depositing and compacting of the concrete. Precast concrete-blocking should be used where applicable. The use of pebbles for blocking is prohibited.

Placing and fastening of reinforcement in each section of the work shall be approved by the engineer before any concrete is deposited in the section.

When bar-bending diagrams are not shown on the contract plans, detail plans showing the bending of reinforcing bars shall be submitted to the engineer for approval.

Splicing Reinforcement.- Whenever it is necessary to splice reinforcement at points other than those shown on the plans, drawings showing the location of each splice shall be submitted and approved by the engineer before the reinforcing steel is ordered. Splices shall be avoided at points of maximum stress; they shall, where

possible, be staggered, and shall be designed to develop the strength of the steel without exceeding the allowable unit bond-stress. When sheets of metal mesh or expanded metal are used they shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the edges.

Determination of Weight.- The weight of steel to be paid for shall be the theoretical weight of the steel placed as shown on the plans and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars, as the case may be, of equal nominal size. If steel mesh or expanded metal is required, the weight per square foot will be shown on plans.

Basis of Payment.- The weight of steel thus determined shall be paid for at the contract unit price bid for "Reinforcing Steel", which price shall be full compensation for furnishing the materials, all equipment, tools, labor, and incidentals necessary to complete the item. No allowance will be made for the clips, wire, separators, or other material used for fastening the reinforcing steel in place.

BRONZE BEARING-PLATES

Description.- Bronze bearing-plates, conforming to these specifications, of the sizes and dimensions shown on the plans, shall be furnished and placed as called for on the plans or as directed.

Material.- Bronze bearing-plates shall meet the requirements for bronze bearing-metals for turntables and movable railroad bridges, Serial Designation B-22-21 Class-B Material of the American Society for Testing Materials. Bronze castings shall be free from inclusions of foreign material, casting faults, injurious blowholes or other defects rendering them unsuitable for the service intended.

Construction Methods.- Bearing plates shall be accurately set in correct position as shown on the plans and shall have uniform bearing over the total area. They shall be securely anchored to the concrete with bolts set in the concrete of the size and as shown on the plans. Sliding surfaces shall be planed parallel to the movement of the spans and polished and shall be thoroughly coated with graphite and grease just before being placed in position, and special care shall be taken to avoid placing concrete in such a manner as to interfere with their free action.

Basis of Payment.- Payment will be made at the contract unit price bid per pound for "Bronze Bearing-Plates" complete in place, which price will be full compensation for furnishing material including bolts, all equipment, tools, labor, and incidentals necessary to complete the item.

STRUCTURAL STEEL

Description.- This item shall consist of furnishing, fabricating, preparing, erecting and painting all structural steel, steel castings and forgings, rivet and eyebar steel, cast iron, malleable castings, also drain pipes in steel spans; all complying with the dimensions, shapes and design prescribed on the plans and as

required by these specifications and by the specifications under "Concrete Bridges" and "Steel Bridges". Any structural steel in timber structures shall not be included in this item but shall be included under the "Timber Bridge" item.

Material.- Structural steel, including rivets, eyebars, drain pipes on steel spans only, pins, anchor bolts, and castings shall meet the requirements therefor contained in U. S. Department of Agriculture Bulletin No. 1259.

Construction Methods.- Ample notice must be given the engineer by the contractor regarding the source of materials and the name and location of the fabricating company in order to allow for arrangement for both mill and shop inspection of all materials and fabrication.

The contractor shall furnish all shop-detail plans and any material ordered prior to the approval of these plans shall be at the contractor's risk. These details must conform to the general drawings, stress sheet and specifications, and no deviation from the approved shop plans will be allowed without the written consent of the engineer. The contractor shall be responsible for the correctness of the drawings and for shop fits and field connections even though the drawings have been approved by the engineer.

The shop drawings shall not exceed 22 inches by 36 inches in size and three sets of blueprint copies shall be submitted to the engineer for checking, one of which will be returned, with either approval or required revisions noted thereon. After final corrections and approval, three additional sets of blueprints, together with one set of tracings or vandyke negatives shall be furnished the engineer. No additional payment will be made for these plans, but the cost thereof shall be included in the bid price for steel.

The contractor shall furnish the engineer with duplicate copies of material orders and triplicate copies of shipping statements. If payment is made on a pound-price basis, the weights of individual members shall be shown on the shipping statements; and if shop-scale weights are used, the shipping statements must be certified to by the engineer's shop inspector in whose presence the weights were obtained.

Fabrication, testing, handling and shipping shall conform to the requirements contained in U. S. Department of Agriculture Bulletin 1259. Shop assembling, subpunching and reaming of all field holes in truss members will be required. Floor-beam connections shall be subpunched and reamed to a steel template. The shop paint consists of red-lead paint as provided for in the paint specifications under "Steel Bridges".

Erection of steel spans shall conform to the requirements contained in U. S. Department of Agriculture Bulletin 1259.

Where timber decks are provided, the top flanges of all stringers and floor beams shall be protected by a covering composed of a heavy layer of bituminous material (tar, asphalt or pitch) applied hot and one thickness of two-ply tar-paper wide enough to project three inches beyond the edges of the members. These edges shall be bent down at an angle of 45 degrees.

Method of Measurement.- When pound-price bids are required in the special provisions, the quantities to be paid for under this item shall be the weight of metal in the fabricated structure completed and accepted, which weight will include the weight of the actual number of field rivets required. The weight of erection bolts, field paint and all boxes and crates or other containers used for packing, together with sills, struts and rods used for supporting members during transportation shall be excluded. For the purpose of measurement for payment, steel and iron castings, anchor plates, steel plates and shapes for expansion joints and pier protection, all metal conduits, scuppers, pipes and drains in the superstructure, all zinc and other similar metals required in the superstructures shall be considered as structural steel.

The weights paid for shall be shop-scale weights unless otherwise provided. Finished work shall be weighed in the presence of the engineer's shop inspector if practicable. The contractor shall supply satisfactory scales and shall perform all work involved in handling and weighing the various parts. When it is not practicable to obtain the shop-scale weights of the individual members in the presence of the inspector, and it is so ordered, payment will be based on the computed weight. In any case if the total scale-weight of any structure exceeds the computed weight by more than 2 per cent, the weight in excess of 2 per cent over the computed weight shall not be paid for.

If the weight of any member is more than 2 per cent less than the computed weight it shall be cause for rejection at the option of the engineer. This applies both to pound-price and lump-sum contracts.

The computed weight shall be calculated in accordance with the following provisions and shall be based on the following assumptions.

The weight of steel shall be assumed at 490 pounds per cubic foot. The weight of rolled shapes, and of plates up to and including 36 inches in width, shall be computed on the basis of their nominal weights and dimensions, as shown on the approved shop drawings, deducting for copes, cuts, and open holes. The weights of plates wider than 36 inches shall be computed on the basis of their dimensions, as shown on the approved shop-drawings, deducting for cuts, and open holes. To this shall be added one-half of the allowed percentages of overrun in weight given in the standard specifications for structural steel for bridges, Serial Designation A-7-24, of the American Society for Testing Materials. The weight of heads of shop-driven rivets shall be included in the computed weight, assuming the weights to be as follows:

Diameter of rivet Inch	Weight for 100 button heads Pounds
1/2	4.4
5/8	9.0
3/4	15.0
7/8	23.0
1	33.0

The weight of castings shall be computed from the dimensions shown on the approved shop-drawings, with an addition of 10 per cent for fillets and overrun. To the total computed weight of metal may be added an allowance of 0.4 of one per cent for shop paint.

When lump-sum bids are required in the "Special Provisions" the bidder will tender a price for each superstructure complete, of the length and type shown in the bid schedule.

Basis of Payment.- Payment will be made on a pound-price basis or a lump-sum basis as required in the "Special Provisions". When pound-price bids are required in the "Special Provisions", the weight determined as provided above shall be paid for at the unit contract prices per pound bid for "Structural Steel", which prices shall be full compensation for furnishing, fabricating, delivering, erecting and painting, and all materials, labor, equipment, tools, and incidentals necessary to complete the item. All pay items not covered above shall be measured and paid for as provided for under the items "Method of Measurement" and "Basis of Payment" for "Steel Bridges".

When lump-sum bids are required in the "Special Provisions", each completed and accepted superstructure shall be paid for as a whole at the lump-sum price bid for each "Steel-Bridge Superstructure" of the length specified, which price shall be full compensation for the complete structure above foundation or supports or piling caps except the floors and wearing surface of the floor as indicated on the plans. Any extra metal indicated and classified on the plans as "Extra Structural Steel" shall be paid for at the unit price bid per pound for "Extra Structural Steel", based on the weight shown on the plans.

CEMENT RUBBLE-MASONRY.

Description.- Cement rubble-masonry shall be composed of approved stones laid in mortar beds and shall be constructed in conformity with the plans or as directed in writing by the engineer.

Material.- The Portland Cement, sand, and water for the mortar shall be such as to conform with the respective requirements for these materials as contained in the specifications hereinbefore given for concrete.

The stone for rubble masonry shall be clean, hard, and of a kind known to be durable. The individual stones, except for filling joints, shall have a thickness of not less than 5 inches and a width of not less than one and one-half times the thickness with a minimum width of 12 inches. No stone, except headers, shall have a length less than one and one-half times its width.

Construction Methods.- All rubble masonry shall be constructed by experienced workmen. Selected stones, roughly squared and pitched to lines, shall be used at all angles and ends of walls. All stones shall be thoroughly wet prior to laying and be laid with practically horizontal beds. Large flat stones shall be selected for the bottom course. All stones shall be fully bedded in Portland-cement mortar, mixed in the proportion of 1 part cement to 3 parts of sand and shall be so placed as to break joints at least 6 inches and form a firm bond. Mortar which is not used within 30 minutes after water has been added shall be wasted. Re-tempering of mortar will not be permitted.

For mortar, the sand and cement shall first be mixed dry in a tight box until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains a consistency such that it can be easily handled and spread with a trowel.

Headers shall be distributed uniformly through the walls of the structures so as to form at least one-fifth of the exposed faces. They shall be of such lengths as to extend through the face wall into the backing at least 12 inches, and where a wall is less than 18 inches in thickness the headers shall extend entirely through from front to back face.

The interior of the walls shall be built up so that the stones of which it is composed will be bonded, and so that no open spaces will be left. Horizontal joints in the face shall not exceed 1 inch in thickness and vertical joints shall not exceed 2 inches in width. No spalls shall be used in the face of a wall, and the face stones shall be so well bedded that none will be needed. Walls shall be provided with weep holes wherever called for on the plans or directed by the engineer. If a stone is loosened after the mortar has set it shall be removed, the mortar cleaned off, and the stone relaid with fresh mortar.

This class of masonry shall be finished with a concrete coping or with a top course consisting of roughly-shaped stones. Bridge seats and back walls, unless otherwise specified, shall be of Class-B concrete, which shall be not less than 8 inches thick and wide enough to cover the full width of the wall and shall be cast in place. If a stone coping is specified, the stones shall be not less than 8 inches thick, from 1-1/2 to 4 feet long and wide enough to cover the top of the wall, set in full mortar-beds as shown on the plans.

After the stone is all laid as above specified the face joints shall be thoroughly cleaned of all mortar to a depth of 1 inch. The joints shall then be wetted and pointed with Portland-cement mortar, mixed in the proportion of 1 part of cement to 1 part of sand. No pointing shall be done in freezing weather, and any work damaged by frost shall be removed and replaced. In hot or dry weather the pointed masonry shall be satisfactorily protected from the sun and kept wet for a period of three days after completion.

No masonry shall be laid in freezing weather without the permission of the engineer and the use of such precautions as he may direct to be taken. In hot or dry weather the masonry shall be protected from the sun at least three days after laying.

Method of Measurement and Basis of Payment.- This work shall be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the engineer, and will be paid for at the unit price bid per cubic yard for "Cement Rubble-Masonry" complete in place, which price will be full compensation for the concrete coping or stone top-course, whichever is required, for the concrete bridge-seats and back-walls, and for all materials, equipment, tools, labor, and incidentals necessary to complete the item.

DRY RUBBLE-MASONRY

Description.- Dry rubble-masonry shall be composed of approved stones laid without mortar and so as to fit neatly and firmly, and shall be built in conformity with the plans or as directed by the engineer.

Material.- The stones shall be sound, durable, free from structural defects, and shall be free from rounded or worn surfaces, and clean of earth clay or other foreign substances. No stone shall be used which has a minimum thickness of less than 5 inches, a minimum width of less than 12 inches, or which is less than 1/2 cubic foot in volume. In the lower course of a dry rubble-wall no stone shall be used which has a volume of less than 1 cubic foot. Small stones may be used for pinning and filling interstices in the heart of the wall.

Construction Methods.- All dry rubble-masonry shall be constructed by experienced workmen. The stone shall be roughly dressed on beds and joints and laid on natural beds, being well bonded and breaking joints at least 6 inches. Walls need not be built in courses, but shall be so constructed that no part is materially in advance of the other. In all cases the base thickness of dry walls shall be at least one-half the height, which shall not exceed 8 feet. Headers shall be distributed uniformly throughout the wall, so as to form approximately one-fifth of the exposed faces, and shall extend through the face wall and into the backing at least 12 inches. Where a wall is less than 18 inches in thickness, the headers shall extend entirely through from front to back face. Where the wall is more than 18 inches thick, the headers shall either extend entirely through or overlap at least 6 inches. Walls shall be built up so as to leave no appreciable open spaces, and only sufficient spalls shall be used to wedge the larger stones in place. This class of masonry shall be finished with a top course or coping consisting of roughly-shaped stones not less than 6 inches thick, from 1-1/2 to 4 feet long, and wide enough to cover the top of the wall, carefully laid in solid beds.

Method of Measurement and Basis of Payment.- This work will be measured in accordance with the dimensions shown on the plans, except where changes are ordered by the engineer, and will be paid for at the unit price bid per cubic yard for "Dry Rubble-Masonry" complete in place, which price will be full compensation for the coping and for all materials, equipment, tools, labor, and incidentals necessary to complete the item.

REINFORCED-CONCRETE PIPE

Description.- This item shall consist of furnishing concrete pipe conforming to these specifications and of the sizes and dimensions required on the plans, and installing such pipe at such places as are designated on the plans or by the engineer and in conformity with the lines and grades given. This item shall include the furnishing and construction of such joints and such connections to existing pipes, catch basins, endwalls, etc., as may be required to complete the work as indicated on the plans.

Materials and Manufacture.- Concrete pipe shall be manufactured of Class-A concrete and of reinforcing steel conforming to the specifications for those items herein elsewhere prescribed.

All concrete pipe 12 inches or more in diameter shall be reinforced as hereinbelow specified and shall be of the bell-and-spigot type unless some other type is specified or shown on the plans or in the "Special Provisions". Each section

shall have square ends, be circular or elliptical in cross section unless otherwise specified, and have walls of uniform thickness throughout, except the bell end which at a point 1/4-inch from the end of the bell shall have a thickness of not less than three-fourths of the wall thickness.

The pipe shall be cast in sections. When no specific length is specified the sections shall be manufactured in standard lengths of not less than 3 feet. The smallest inside diameter shall govern in designating the size of any given pipe.

The bell end shall be so constructed that the spigot will enter to a depth as required below:

12 to 18-inch pipe not less than 2-1/2 inches
24 to 36-inch pipe not less than 3 inches

The surface of all pipe both interior and exterior shall be smooth and even, of uniform texture, free from surface checks, cracks, blisters, fractures, laminations, lean and poor spots. The pipe shall be true to dimensions intended in the design with a permissible variation from the true form of not more than 2 per cent.

The shell thickness shall be such that the cover on the reinforcement shall not be less than 3/4 of an inch at any point. Variation in the position of the reinforcement shall not exceed 1/4-inch from the position provided in the design.

The date of manufacture and the name or trademark of the manufacturer shall appear on each section of pipe. Elliptical pipe with circular reinforcing and circular pipe with elliptical reinforcing shall have the word "Top" clearly stencilled on the inside of the pipe so as to indicate the proper position when installed.

Reinforcement shall be of the fabrication adopted by the manufacturer when not specifically prescribed on the plans, and in all cases shall extend into the bell of the pipe.

When a single line of circular reinforcement is used in circular pipe, it shall be placed at the center of the pipe shell. When two lines of reinforcement are used in circular pipe, one shall be placed near the inner and one near the outer surface of the pipe. The single line of elliptical reinforcement used in circular pipe or the single line of elliptical reinforcement in elliptical pipe shall be placed near the inner surface in the vertical or major axis, and near the outer surface in the horizontal or minor axis. The bell shall have circumferential reinforcement equal in unit area to that of a single line within the barrel of the pipe.

All pipe shall have sufficient strength so that when tested in accordance with the three-edge bearing-method as prescribed in the A.S.T.M. specifications for cement-concrete sewer-pipe, Serial Designation C-14-24, as amended to date of contract, it shall have a crushing strength in pounds per lineal foot of not less than 2,000 D, where D equals the diameter of the pipe in feet. This requirement may be increased for pipes under high fills as required in the "Special Provisions".

Each manufacturer of pipe shall provide a suitable apparatus for testing his product, in accordance with the above requirements. Upon the request of the engineer and under his supervision the manufacturer shall perform such test and in such manner as the engineer may deem necessary in order to establish the quality of the product, as required by these specifications. No payment or allowance shall be made to the manufacturer for such equipment, expenses in testing, or for the pipe broken. The manufacturer shall furnish facilities for inspection during the manufacture.

When tested for absorption the density and quality of the pipe shall be such that when tested by the absorption test as prescribed for the "Boiling Test" of the A.S.T.M. specifications for "Drain Tile", Serial Designation C-4-24, and amendments to date of contract, the standard test-specimens shall have a maximum average-absorption not exceeding 8 per cent. Individual samples in a standard test may fall 25 per cent above the requirements for the average without causing rejection.

Installation.- The pipe shall be laid with the lowest point of the inside circumference conforming to the flow lines shown on the plans. The bottom of the trench shall be made to conform to the shape of the pipe which shall rest on a solid bed for its entire length with bell ends upstream. In case the existing foundation material is soft or yielding, the same shall be removed and replaced as provided under the items "Excavation for Structures" and "Foundation Fill".

The joints of the pipe shall be sealed with cement mortar composed of one part Portland cement and two parts sand. These materials shall conform to the appropriate requirements prescribed under "Concrete". Care shall be taken to prevent the intrusion of mortar into the inside of the pipe in such a manner as to obstruct the flow of water.

Method of Measurement.- Footage to be paid for shall be the actual number of lineal feet of pipe installed in place, completed and accepted.

Basis of Payment.- The footage measured as provided above shall be paid for at the contract unit price per lineal foot bid for "Reinforced-Concrete Pipe" of the several sizes, which prices shall constitute full compensation for furnishing or manufacturing, hauling and installing pipe, and for all materials, labor, equipment, tools, and incidentals necessary to complete this item, but shall not constitute payment for concrete or masonry headwalls or for excavation.

CORRUGATED GALVANIZED-METAL PIPE

Description.- This item shall consist of furnishing sheet-metal pipe conforming to these specifications and of the sizes and dimensions required on the plans, and installing such pipe where and as designated on the plans or by the engineer and in conformity with the lines and grades given. This item shall include the furnishing and construction of such joints, and such connections to existing pipes, catch basis, end walls, etc., as may be required to complete the work as shown on the plans.

Material and Manufacture.- The pipe shall be fabricated from corrugated galvanized-sheets, the base metal of which shall be made by the open-hearth process.

The base metal shall conform to one of the following sets of chemical require-

Elements	Chemical composition by ladle analysis. Position of base metals does not indicate preference					Tolerance by check analysis of finished sheets
	Pure iron	Copper-bearing pure-iron	Copper-iron	Copper-molybdenum-iron	Copper-steel	
Carbon Maximum per cent	--	--	--	--	--	--
Manganese Maximum per cent	--	--	--	--	--	--
Phosphorus Maximum per cent	.015	.015	.015	.015	--	--
Sulphur Maximum per cent	.040	.040	.040	040	.050	.010
Silicon Maximum per cent	--	--	--	--	--	--
Copper Minimum per cent	--	.20	.20	.40	.20	.02
Molybdenum Minimum per cent	--	--	--	.05	--	--
Sum of first five elements Maximum per cent	--	.10	.25	.25	.70	.04
Sum of first six elements Maximum per cent	.10	--	--	--	--	.04

All rivets shall be of the same material as the base metal specified for the corrugated sheets. They shall be thoroughly galvanized or sherardized.

The weight of the culvert sheets, as determined by weighing in lots not exceeding 6,000 pounds, shall not vary from the theoretical weight by more than 5 per cent either way for each lot of one gauge and size.

The base-metal sheets shall be uniformly galvanized on both sides by the hot process. A uniform coating of Prime-Western spelter shall be applied at the rate of not less than 2 ounces per square foot of metal. If the average spelter-coating as determined from samples shows less than 2 ounces of spelter per square foot of metal, or if any one sample shows less than 1.8 ounces of spelter per square foot of metal, the shipment shall be rejected. Sheets having blister spots, holes, or other imperfections in the galvanizing after corrugating shall be rejected.

No metal will be accepted under these specifications and no bids will be considered for the materials above described until after the sheet manufacturer's certified analysis and manufacturer's guarantee have been passed upon by the engineer and accepted.

Misbranding or other misrepresentation and non-uniformity of product will each be considered a sufficient reason to discontinue the acceptance of any brand under these specifications, and the notice of discontinuance of any brand sent to the sheet manufacturer will be considered to be notice to any culvert companies which handle that particular brand.

The manufacturer of each brand shall file with the engineer a certificate setting forth the name or brand of metal to be furnished and a typical analysis showing the percentage of each of the five above-mentioned chemical elements. The certificate shall be sworn to for the manufacturing company by a person having legal authority to bind the company.

The manufacturer of the sheets shall submit with the certified analysis a guarantee providing that all metal furnished shall conform to the certified analysis filed, shall bear a suitable identification brand or mark, and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge, or spelter coating; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.

No culverts will be accepted unless the metal is identified by a stamp on each section showing: First, name of sheet manufacturer; second, name of brand; third, the gauge.

The identification brands shall be placed on the sheets by the manufacturers of the sheets, in such a way that when rolled into culverts such identification shall appear on the outside of each section of each pipe. Pipe having any sections not so stamped shall be promptly rejected.

Laboratory tests shall follow the methods of the United States Department of Agriculture Bulletin No. 1216, Revised.

If the engineer so elects, he may have the material inspected at the rolling mill or the culverts inspected in the shop where they are fabricated. He may require a chemical analysis from the mill for any heat, also a physical test of the properties of the metal taken from any heat, to be made by the mill. The inclusion in any shipment of any material which has been rejected at the mill or shop will be considered sufficient cause for the rejection of the entire shipment.

Construction of Pipe.- Pipe furnished under these specifications shall be of the full-circle riveted type, with lap-joint construction.

The length of culvert specified shall be the net length of the finished culvert which does not include any material used to procure an end-finish on the pipe. If the average deficiency in length of any shipment of pipe is greater than 1 per cent, the shipment shall be rejected.

All pipe shall be furnished in the lengths ordered, except that pipe for culverts 26 feet or more in length may be furnished in sections not less than 12 feet in length, provided all necessary field couplings are furnished free of charge. For small shipments involving less than carload lots, the above requirements may be modified by written authority from the engineer.

The length of sheets, widths of laps, gauge of the uncoated metal (United States standard gauge), and theoretical weight per lineal foot of the finished culvert shall be as specified in the following table. The dimensions given for diameter of pipe are nominal. The average weight per lineal foot of a finished culvert, exclusive of end fittings, shall not underrun the theoretical weight specified by more than 5 per cent.

Nominal diameter	Length of sheet before forming	Width of lap	Minimum gauge United States standard	Weight per lineal foot of finished culvert
Inches	Inches	Inches		Pounds
12	40	2.0	16	10.5
15	50	2.0	16	13.1
18	60	2.5	16	15.7
21	70	2.5	14	22.5
24	80	3.0	14	25.8
30	100	3.5	14	32.2
36	120	3.5	12	53.3
42	-	-	10	-
48	-	-	10	-

The gauge of the sheets may be increased as noted in "Special Provisions" for culverts under high fills.

Corrugations shall be not less than 2-1/4 nor more than 2-3/4 inches from center to center. The corrugations shall have a depth of not less than one-half inch.

Rivets shall have the following dimensions:

No. 16-gauge material (two thicknesses of sheets), 5/16 inch by 1/2 inch
No. 14-gauge material (two thicknesses of sheets), 5/16 inch by 5/8 inch
No. 14-gauge material (three thicknesses of sheets), 5/16 inch by 3/4 inch
No. 12-gauge material (two thicknesses of sheets), 3/8 inch by 3/4 inch
No. 12-gauge material (three thicknesses of sheets), 3/8 inch by 7/8 inch

All rivets shall be driven cold in such a manner that the plates shall be drawn tightly together throughout the entire lap. No rivet shall be closer than twice its diameter to the edge of the metal. All rivets shall have neat, workmanlike, and full hemispherical heads or heads of a form acceptable to the engineer; shall be driven without bending; and must completely fill the hole. Longitudinal seams of 30 and 36-inch pipe shall be double riveted. Circumferential shop-riveted seams shall have a maximum rivet-spacing of 6 inches and shall lap at least one full corrugation, except that six rivets will be sufficient in 12-inch pipe.

If a band is used for end-finish, it shall be riveted around the end of the culvert with rivets at intervals of 10 inches or less. This band shall be of galvanized metal equivalent in cross section to 3/8 by 1 inch for 16-gauge metal, 3/8 by 1-1/2 inches for 14-gauge metal and 12-gauge metal.

Field joints shall be made with bands of the same material as the culvert, and shall be not less than 7-1/2 inches wide, so constructed as to lap an equal portion of each of the culvert sections to be connected. Such bands shall be connected at the ends by angles having minimum dimensions of 1-1/2 inch by 1-1/2 inch by 1/8 inch, and of length equal to the full width of the band, or by other approved connections of suitable strength. Each connection shall be fastened by at least two bolts not less than 1/2-inch in diameter. All such connections shall be made of galvanized metal of the same quality as the base metal in the culvert.

Culvert pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which show defective workmanship, shall be rejected. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert pipe or in in general in any shipment shall constitute sufficient cause for rejection: Uneven laps; elliptical shaping; variation from a straight center-line; ragged or diagonal-sheared edges; loose, unevenly-lined or -spaced rivets; poorly-formed rivet-heads; unfinished ends; illegible brands; lack of rigidity; bruised, scaled, or broken spelter-coating; dents or bends in the metal itself.

The contractor shall furnish an itemized statement of the sizes and lengths of culvert pipe in each shipment. The pipe making up the shipment shall fully meet the requirements of these specifications, and if 50 per cent of the pipe in any shipment fails to meet these requirements the entire shipment may be rejected.

When samples are taken for chemical analysis and determination of weight or spelter coating, at least one sample from which a specimen 2-1/4 inches square may

be prepared shall be selected from each 10 culverts of a shipment, and not less than three samples shall represent any one shipment.

Installation.- Culverts under the highway shall be placed so that the minimum distance from the finished surface of roadbed to the top of pipe shall be not less than one-half the diameter of the pipe with a minimum of 1 foot.

The pipe shall be laid in the trench with the separate sections firmly joined together and with outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any metal in joints which is not thoroughly protected by galvanizing shall be coated with a suitable asphaltum paint.

The pipe shall be laid with the lowest point of the inside circumference conforming to the flow lines shown on the plans. The bottom of the trench shall be made to conform to the shape of the pipe which shall rest on a solid bed for its entire length.

When installing 42-inch and 48-inch pipes, or any pipes under a high fill, timber struts shall be placed inside the pipes as required by the engineer and shall remain in place until the backfill over the pipe is completed.

Method of Measurement.- The footage to be paid for shall be the actual number of lineal feet of the pipe installed in place, completed, and accepted.

Basis of Payment.- The footage, measured as provided above, shall be paid for at the contract unit prices per lineal foot bid for "Corrugated Galvanized-Metal Pipe" of the several sizes, which prices shall constitute full compensation for furnishing, hauling and installing the pipe, and for all materials, labor, equipment, tools and incidentals necessary to complete this item, but shall not constitute payment for concrete or masonry headwalls or for excavation.

INCIDENTAL CONSTRUCTION

PILING

Description.- This item shall consist of furnishing and driving untreated timber, treated timber, or concrete piles of the kind and dimensions designated, complying with these specifications, and driven to the required penetration and in accordance with the lines and spacing shown on the plans within an allowed variation of the direction of the pile of not more than 1/4-inch per foot of length. The contractor shall assume the responsibility for ordering the necessary piles for the work. No allowance will be made for any footage of piles not actually used in the work below cutoffs except as hereinafter provided for concrete piles, except test piles provided for in the "Special Provisions" and ordered in writing.

Concrete piles when properly designed, constructed, and placed may be subjected to loads as determined by tests or formula, but not to exceed 300 pounds per square inch of total cross section at the smallest effective point and generally not to exceed 25 tons per pile, with a maximum limit of 30 tons per pile.

When piles are cast in strong metal-shells which have been driven in accordance with the specifications for driving concrete piles and which remain in place after the concrete has set, the safe loads for piles completely embedded in firm earth may be taken the same as specified for other concrete piles. Piles cast in place without metal reinforcement shall not be used in water or in ground so soft in either wet or dry condition, as not to give firm lateral support.

When so required in the "Special Provisions" the size and number of piles to be used shall be determined by actual loading tests. In general these tests shall consist of the application of a test load placed upon a suitable platform supported by the pile, together with suitable apparatus for accurately determining the superimposed weight and the settlement of the pile under each increment of load. The safe allowable load shall be considered as 50 per cent of that load, which, after 48 hours application, causes a permanent settlement, measured at the top of the pile, of not more than 1/4-inch. At least one pile for each group of 100 piles shall be thus tested.

When so required in the "Special Provisions", the contractor shall drive test piles of a length and at the location designated by the engineer. These piles shall be of greater length than the length assumed in the design in order to provide for any variation in soil conditions.

In the absence of tests as above described the safe bearing-value of each timber pile shall be determined by the following formula:

For gravity hammers, $P = \frac{2WH}{S+1}$

For single-acting steam-hammers, $P = \frac{2WH}{S+0.1}$

For double-acting steam-hammers, $P = \frac{2H(W+Ap)}{S+0.1}$

In the above formula P = safe load per pile in pounds,

W = weight of falling hammer in pounds

H = height of fall in feet

A = area of piston in square inches

p = steam pressure in pounds per square inch at hammer

S = the average penetration per blow in inches for the last 5 blows of a gravity hammer or the last 20 blows of a steam hammer

The above formula is applicable only when

a.- The hammer has a free fall.

b.- The head of the pile is free from broomed or crushed wood-fiber or otherwise seriously impaired.

c.- The penetration is at a reasonably quick and uniform rate.

d.- There is no sensible bounce after the blow. Twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.

The bearing powers of timber piles as determined by the foregoing formulas shall be considered effective only when they are less than the crushing strength of the piles.

The formulas specified above for timber piling may be used as a rough approximation for the bearing value of precast concrete piles and they may also be applied to the driven core of cast-in-place piles.

In all cases, when tested by formula, piles shall be driven if possible until their safe bearing-value is not less than 20 tons for timber piles and 30 tons for concrete piles.

In case the safe bearing-value of any pile is found by test, or by formula if not tested, to be less than the load that it was intended to carry, additional piles shall be driven until the load per pile is reduced to the safe bearing-value found, or plans showing the necessary modification of the design of the footings and the number and location of the piles required will be furnished by the engineer and the work constructed accordingly.

The carrying capacity of jetted piles shall be determined by actual tests or by the same method and formula as in the case of unjetted piles, provided that no jet be used during the test blows.

Material Requirements for Untreated Timber-Piles. -

(a) Foundation Piles. - Unless otherwise specified these piles may be of any species which will satisfactorily stand driving, and they may be either round or square. They shall be cut from live, sound trees, shall be solid and free from defects such as injurious ring shakes, large unsound or loose knots, decay, or other corresponding defects which might impair their strength or durability. They shall be cut above the ground swell and have a uniform taper and shall be free from short bends. A straight line drawn from the center of the butt to the center of the tip shall lie wholly within the body of the pile. Piles shall be peeled soon after cutting. All knots shall be trimmed close to the body of the pile. For round piles the minimum diameter shall be 8 inches at the tip and 12 inches at the butt. The maximum diameter at the butt shall be 20 inches. Square piles shall be uniform in cross section, not less than 10 inches by 10 inches for lengths up to 30 feet, nor less than 12 inches by 12 inches for lengths over 30 feet.

If possible, piles shall be full length. Where the length required is greater than is practical to obtain, they may, upon written approval of the engineer, be spliced. All splices shall be made in accordance with detail plans prepared to meet the special conditions encountered and which shall be approved before the piles are driven.

(b) Trestle Piles and Foundation Piles for Trestle Bents. - These piles shall meet the requirements for timber foundation-piles and in addition shall be of a durable species, as required on the plans or in the "Special Provisions". Generally untreated timber-piles shall be used only below permanent ground-water level and shall not be used in water which is infested by marine borers

Material Requirements for Treated Timber-Piles. - Requirements for treated foundation-piles, treated trestle-piles, and treated foundation-piles for trestle bents, shall be identical with the corresponding requirements for untreated timber-piling, with the additional requirements following:

Piles shall be treated with the preservative prescribed in the specifications for timber structures.

The ranges of pressure, temperature, and time duration of treatment shall be controlled so as to result in the maximum penetration of the quantity of preservative injected, which shall permeate all of the sapwood and as much of the heartwood as practicable.

Material Requirements for Concrete Piles. - All concrete materials and their preparation and placing shall be in accordance with the requirements for Class-A concrete, except that the maximum size of coarse aggregate shall be 1 inch.

Reinforcement shall conform to the requirements for reinforcing steel of these specifications, and the weight and dimensions shall be as shown on the plans.

Where waterproofing is to be used, special specifications will be given and the work shall be in accordance therewith.

The average diameter shall not be less than 12 inches, and the diameter at the point not less than 8 inches. The length shall not exceed 30 times the average diameter for piles driven through firm soil, and shall not exceed 15 times the average diameter for piles driven to rock through loose, wet soil, or filled ground. When lateral support is deficient, so that the piles act as columns, they shall be designed as columns.

Precast piles shall be made in accordance with the plans, and reinforcement shall be accurately placed and rigidly secured in such manner as to insure its proper location in the completed pile. Special reinforcement at the top and bottom to protect them from damage in driving shall be provided. The centers of the main reinforcing bars shall be not closer to the surface of the concrete than 2½ inches. The concrete shall be carefully placed, tamped, and spaded, care being taken to fill every part of the form and to work the concrete around and under the reinforcement without displacing it. The piles shall be cast separately, or, if alternate piles are cast in a tier, the intermediate piles shall not be poured until four days after pouring the adjacent piles. Piles cast in tiers shall be separated by tar paper carefully placed. The concrete shall be placed continuously in each pile. The completed piles must be free from stone pockets, porous spots, or other defects, and be straight and true to the form specified. The forms shall be true to line, built of dressed lumber, and a 1-inch chamfer-strip shall be used in all corners; they shall be water-tight and shall not be removed within 24 hours after the concrete is placed. All exposed surfaces of the pile shall be given a rubbed finish. The piles shall be cured at least 40 days at a temperature of not less than 40°F., or 30 days at a temperature of not less than 60°F. Piles shall be at least 30 days old when driven. When concrete piles are lifted or moved they shall be supported at the quarter points and they shall be so designed that the unit stresses produced by handling, as described above, will not exceed 650-pounds-per-square-inch compression in concrete nor 16,000-pounds-per-square-inchtension in steel.

Construction Methods for All Piles. - Piles shall be used only in places where a minimum penetration of 10 feet in firm material, or 20 feet in soft material, can be obtained. For foundations of arch, continuous span, or movable bridges or high abutments, the piles shall be completely embedded in firm earth, sand or gravel which will afford good lateral support. When this result is impracticable, the soft

material shall be excavated from the pit and replaced by heavy riprap, for such distance and depth as the plans indicate or the engineer directs in writing.

All excavation of the foundation in which piles are to be driven shall be complete before driving is commenced. After driving is completed, all loose and displaced materials shall be removed from around the piles, leaving a clean, solid surface to receive the concrete.

When subject to transverse forces, batter piles shall be driven in sufficient numbers to resist the transverse forces without assistance from the vertical piles.

Driving Piles. - Timber piles shall be provided with a metal collar when necessary to prevent splitting in driving. Metal shoes of an approved design shall also be used when ordered in writing by the engineer.

When water jets are used the number of jets and the volume and pressure of the water at the jet nozzles shall be sufficient to freely erode the material adjacent to the piling. The plant shall have sufficient capacity to deliver at all times a pressure of at least 100 pounds per square inch at two 3/4-inch jet nozzles. Before the desired penetration is reached the jets shall be withdrawn and the piles shall be driven by the hammer to secure the final penetration.

Requirements for Driving Concrete Piles. - It is preferable that concrete piles shall be driven with a steam hammer. Steam hammers for this purpose shall develop an energy per blow, at each full stroke of the piston, of not less than 3,500 foot pounds per cubic yard of concrete contained in the pile being driven. The total energy developed by the hammer shall be not less than 12,000 foot pounds per blow.

Gravity hammers, when used, shall have a weight not less than that of the pile and the maximum drop shall not exceed 8 feet.

Driving Piles Cast in Place. - No pile of this type shall be concreted until all driving within a radius of 6 feet has been completed, and care shall be taken that the piles are in no way disturbed until the concrete has become hard.

The tops of foundation piles shall be embedded in the concrete footing at least 1 foot, and where seals of concrete deposited in water are used with piles, the piles shall project at least 6 inches above the top of the seal-concrete. Timber piles shall be cut off level at such an elevation that the tops of the piles will always be wet. The distance from the side of any pile to the nearest edge of the footing shall not be less than 9 inches.

Timber foundation-piles for framed bents shall be cut off level at the elevations indicated on the plans and the cap rigidly secured to each pile by drift bolts extending at least 9 inches into the pile.

Timber trestle-piles shall be cut off at the elevation shown on the plans and the caps secured as described above. If the cutoff is 10 feet or more above the ground line, timber piles shall be braced by diagonal cross-bracing secured to the piles by 3/4-inch diameter bolts.

Treated piles and timbers shall be carefully handled without sudden dropping, breaking of outer fibers, bruising or penetrating the surface with tools. They shall be handled with rope slings. Cant dogs, hooks, or pike poles shall not be used.

The heads of untreated piles shall be given that one of the two following treatments which is designated in writing by the engineer:

1. - The sawed surface shall be thoroughly brush-coated with two applications of hot creosote-oil.

2. - The sawed surface shall be heavily coated with red-lead paint after which it shall be covered with cotton duck, of at least 8-ounce weight, which shall be folded down over the sides of the pile and firmly secured thereto with large-headed roofing-nails. The edges of the duck shall be trimmed to give a workmanlike appearance. The duck shall then be waterproofed by being thoroughly saturated and coated with one or more applications of red-lead paint.

All cuts in treated piles or timbers and all abrasions after having been carefully trimmed shall be coated with at least three applications of hot creosote-oil and covered with hot roofing-pitch. Before driving bolts hot creosote-oil shall be poured into all bolt holes in such a manner that the entire surface of the hole shall be thoroughly coated with the oil. Any unfilled holes after being treated with creosote-oil shall be plugged with creosoted plugs.

After the necessary cutting has been done to receive the cap, the heads of treated piles shall be given three coats of hot creosote-oil. They shall then be covered with a coat of hot tar-pitch, over which shall be placed a sheet of three-ply roofing-felt or galvanized iron, or a covering may be built up of alternate layers of hot tar-pitch and loose-woven fabric similar to membrane waterproofing, using four layers of pitch and three of the fabric. The cover shall measure at least 6 inches more in each dimension than the diameter of the pile and shall be bent down over the pile and the edges fastened with large-headed nails or secured by binding with galvanized wire.

Method of Measurement. - The footage of piles to be paid for under this item shall be the actual number of lineal feet of piles left in place in the completed work and no allowance will be made for any piles which are not driven in accordance with the specifications, and accepted by the engineer. The footage and number of piles ordered shall be the responsibility of the contractor and no allowance will be made for cutoffs or broken piles or piles ordered and not used, except that where lengths of concrete piles are shown on the plans or specified by the engineer, the length of cutoff shall be paid for at one-half the contract unit price bid, which shall be full compensation for materials, etc., and cutting off.

Basis of Payment. - The footage of piles determined as provided above shall be paid for at the contract unit prices bid per lineal foot for "Untreated Timber-Piling", "Treated Timber-Piling" or "Concrete Piling", as the case may be, complete in place, which prices shall be full compensation for all materials, equipment, treatment, tools, labor, and incidentals necessary to complete the work. When test piles are called for in the "Special Provisions" and bid form they will be measured and paid for as provided therein.

Metal driving-points, when ordered, will be furnished by the Government, unless otherwise specified, but the price per lineal foot of pile shall include all expense incidental to their use, including hauling from the designated point of delivery. Heavy riprap for lateral support in soft material or sheet piling, if ordered in writing shall be paid for under a supplemental agreement or as force account.

HAND-LAID RIPRAP

Description. - Where necessary, slopes shall be protected by hand-laid riprap, which shall be constructed at the places indicated, and of the shape and thickness shown on the plans or directed by the engineer.

Material. - The stone for this work shall be sound, durable, one-man stone not less than 3 inches thick nor containing less than one-half of a cubic foot in volume. No stone shall be used that does not extend through the revetment.

Construction Methods. - The slopes protected shall not be steeper than the angle of repose of the material unless otherwise indicated. The stones shall be placed with their beds at right angles to the slope, the larger stones being used in the bottom courses and the smaller stones at the top. They shall be laid in close contact so as to break joints, and in such manner that the weight of the stone is carried by the earth and not by the adjacent stones. The spaces between the larger stones shall be filled with spalls securely rammed into place. The finished work shall present an even, tight, and reasonably-plain surface, varying not more than 3 inches from the required contour.

Method of Measurement, and Basis of Payment. - This work will be paid for at the unit price bid per cubic yard for "Hand-laid Riprap", complete in place, which price will include all necessary excavation, backfilling, materials, equipment, tools, labor, and incidentals necessary to complete the item.

HAND-LAID ROCK-EMBANKMENT

Description. - Where necessary, slopes shall be steepened on embankments and the embankments strengthened by the use of hand-laid rock which shall be constructed according to the lines and dimensions given by the engineer before work is started.

Material. - The stones for this work shall be sound and durable, not less than one-half cubic foot in volume, and may be taken from the adjacent excavation.

Construction Methods. - An adequate footing shall first be excavated in stable ground along the toe of the slope of the proposed fill. The selected stone material shall be placed by hand on this prepared footing and additional stone laid up to the width and dimensions directed. Care shall be taken to have the stones bonded to some extent and securely bedded. Spalls shall be used to fill voids. The hand-laid rock-embankment thus constructed shall be backed by the usual embankment placed as prescribed under earthwork.

Method of Measurement. - Hand-laid rock-embankment shall be measured when complete in place as ordered. The excavation for the footing prescribed shall not be measured. When stone material for this item is obtained from the roadway or other prescribed excavation, no deduction from the excavation yardage for the stone so used shall be made.

Basis of Payment. - This item shall be paid for at the unit price bid per cubic yard for "Hand-laid Rock-Embankment" complete in place, which price shall be full payment for selecting and placing by hand the material measured, and for all footing excavation, equipment, tools, labor, and incidentals necessary to complete the item.

UNDERDRAINS

Description. - At such places as are shown on the plans or as are designated by the engineer, underdrains shall be constructed. They shall have suitable outlets in culverts, or such other outlets as to drain water entirely away from the road and protect the outlet of the drain. They shall be constructed directly under the gutter or ditch or under the roadway to the line and grade furnished by the engineer and in accordance with the plans and these specifications.

Material and Construction Methods. - Vitrified-Tile Underdrain. - The trench shall be excavated with a bottom width of 12 inches to the line and grade given by the engineer, the depth of trench to vary from 2½ to 3½ feet below the finished surface at the top of the trench. A 2-inch bed of clean gravel or broken stone, all passing a 1-inch screen, shall be spread in the bottom of the trench throughout its entire length and brought to a uniform grade. Salt-glazed, bell and spigot, vitrified drainpipe of the size specified shall be imbedded firmly in the bottom course of stone, with the bell-end upgrade and the spigot-end fully entered in the adjacent bell. The pipe joints shall then be covered with 2-ply tar-paper strips not less than 6 inches in width and of sufficient length to permit the ends being turned outward and laid flat on the bottom course of stone on either side of the pipe for a distance of 3 inches.

After the pipe has been laid and approved by the engineer, clean gravel or broken-stone filling, all passing a 3½-inch screen and retained on a 3/4-inch screen, shall be placed carefully so as not to displace the pipe or joint covering, around and over the pipe to a depth of at least 12 inches above the top of the pipe. The remainder of the trench shall be filled with selected-earth material from excavation. Both stone and surface filling shall be firmly tamped.

Porous-Tile Underdrain. - Porous-tile underdrain shall be laid in the same manner as specified for vitrified-tile underdrain. The tile shall be of specified diameter, of 1/2-inch thickness, and of uniformly-burned clay acceptable to the engineer.

Blind Drain. - Where blind drains are called for, they shall be dug to the cross section shown on the plans and from 30 to 40 inches in depth, depending on the nature and condition of the soil to be drained. The trench thus prepared shall be filled with clean, broken stone or gravel, from 1 to 3½ inches in size, to within 12 inches of the finished ground-surface. The upper 12 inches of the trench shall then be filled with suitable earth material. Both stone and surface filling shall be firmly tamped to avoid future settlement.

Method of Measurement and Basis of Payment. - This item shall be paid for at the contract unit price bid per lineal foot of "Vitrified-Tile Underdrain", "Porous-ous-Tile Underdrain", or "Blind Underdrain", as the case may be, measured complete in place, which price shall be full payment for furnishing and installing pipe and material, back filling, equipment, tools, labor, and incidentals necessary to complete the item.

WOOD GUARDRAIL

Description. - Single-rail guardrail of either rustic, or surfaced and painted timber shall be constructed where called for on the plans or directed by the engineer, and shall conform in all respects to the requirements of the plans or the "Special Provisions".

Material. - The posts and railing shall be of the species of timber specified on the plans or, if not specified thereon, as required by the engineer.

Round or rustic posts shall be straight, sound, and free from injurious defects, and shall be cut from live trees not less than 30 days in advance of use, but not exceeding one year, and be allowed to season with the bark on. Immediately before use in the work, all bark shall be peeled and the logs trimmed smooth of all knots and projections.

Sawed posts and rails shall conform to the requirements for these items in the specifications for timber structures as hereinbefore given for rails and rail posts. Sawed railing shall be of sufficient length to span two panels. It shall be surfaced four sides, and the dimensions indicated shall be construed to mean the nearest commercial size.

White paint shall consist of 3 parts by weight of white lead to 1 part by weight of zinc oxide, uniformly combined and mixed with pure linseed oil to the required consistency for priming or for second and third coat. Turpentine drier may be added to the paint but shall not exceed an average proportion of 1/2 pint of drier to 1 gallon of paint. The white lead and zinc oxide shall be of a reputable and approved brand, ground in oil, and shall be delivered separately on the project in the original containers before being opened or mixed with the linseed oil.

Black paint shall consist of lampblack ground in oil and mixed to the required consistency with pure raw-linseed oil.

Preservative Treatment. - Unless otherwise specified the lower or butt ends of all posts to a point 8 inches above the ground line shall be treated with one of the preservatives specified under timber structures by immersing the timber for a period of four hours in a tank filled with the preservative to the required height, the preservative being kept at a temperature not less than 215° F. nor more than 230° F. The posts shall then be immediately transferred to a tank filled with cold preservative and be kept immersed for not less than two hours, during the final ten minutes of which the temperature of the preservative shall not exceed 150° F. but shall be above the temperature at which the solids separate from the oils. The level of the hot and cold preservatives shall be the same during both immersions.

Where this preservative treatment is specifically not required, the butt or lower ends of sawed posts to a point 8 inches above the ground line shall be painted with two coats of the black paint hereinbefore specified.

Construction Methods. - The posts shall be set vertically to the depth shown on the plans. They shall be maintained in accurate alignment while the post holes are back filled with suitable material and thoroughly tamped in layers. After back filling, the posts shall be sawed to exact grade and sloped or beveled as called for on the plans. Posts and railings shall be so shaped or notched that satisfactory contact surfaces will be obtained where rails are secured to the posts. All rails shall be squarely butt-jointed at posts.

Holes for bolts shall be bored with a bit of the same diameter as the bolt. All bolts shall be given two coats of red-lead shop-paint as specified for structural steel.

Sawed and surfaced guardrail shall be painted with three coats of approved white paint as hereinbefore specified above a point 8 inches above the ground line. All timber to be painted must be seasoned and painting shall be done only when the timber is free from frost and the surface is perfectly dry and clean. No painting shall be done in wet or freezing weather. All paint shall be thoroughly dry before applying the succeeding coats. It shall be applied in good heavy coats, completely covering every part of the surface, and shall be well worked into the joints and open spaces; it shall be so thoroughly and evenly spread that no excessive paint will collect at any point.

Method of Measurement and Bases of Payment. - This item will be paid for at the price bid per lineal foot of "Wood Guardrail" complete in place, measured from outside to outside of end posts; the price bid shall be full payment for all posts and rails, all materials, including nails, bolts, driftbolts, paint, all excavation and back filling, all equipment, tools, labor, and incidentals. Standing timber for round posts and rustic rails, when so noted on plans, will be available for cutting under the same conditions stipulated for standing timber for log bridges. The above measurement and payment shall not include hand-rail erected on timber bridges.

WIRE-CABLE GUARDRAIL

Description. - This item shall consist of two lines of wire cable supported on wood posts and constructed of materials and workmanship as prescribed by these specifications, at such places as shown on the plans or as designated by the engineer, and in conformity with the details and dimensions shown on the plans.

Materials. - All cable shall be manufactured of double-galvanized annealed-steel having the properties hereinafter required. The wire shall be cylindrical in form and be free from scales, inequalities, flaws and splits.

Each wire of the cable shall be galvanized by the hot-dip method and shall have a continuous coating of pure zinc of a uniform thickness, so applied that it will adhere firmly to the surface of the wire, and it shall be capable of withstanding four immersions in a standard testing-solution of copper sulphate without showing any trace of metallic copper on the steel. The first three immersions shall be for a period of one minute each and the fourth immersion for a period of one-half minute.

Three-Quarter-Inch Cable. - The cable shall be composed of 3 strands, each strand having 7 wires. The diameter of the finished cable shall be not less than 3/4-inch. The wire composing the cable shall be of such quality that the finished cable shall satisfy all the requirements hereinafter set forth. All the wires in the cable shall be of the same grade of steel and shall have approximately the same breaking strain.

The lay of the finished cable shall not be more than 7½ inches. The lay of the wires in the strand shall not be more than 4½ inches. The diameter of the finished wires entering into the cable shall not be less than 0.117-inch and not more than 0.124-inch. The minimum-tensile strength of the cable shall be 13,000 pounds.

All wire cable must be shipped upon substantial wooden reels. Each reel shall have the length and weight of the cable plainly and indelibly marked on a strong tag, firmly attached. The wooden reel shall be mounted so that it will revolve, and the cable run off by pulling straight ahead. Precaution must be taken by the contractor in handling the wire cable to prevent the displacement of the galvanizing.

The posts shall be as required for wood guardrail, treated and painted as required therein, and shall conform to the dimensions shown on the plans.

Anchors for all end posts shall consist of a concrete "dead man" and necessary fittings of the design, dimensions, and details shown on the plans.

Construction Methods. - The posts shall be set plumb and firm, spaced 10 feet apart on center, at least 3½ feet in the ground, and to lines and grades given. Posts shall be located from 3½ to 4 feet from the nearest edge of pavement to the near face of post, unless otherwise directed by the engineer. There shall be a 1-inch chamfer around the top of each post. The wire cable shall pass through hook bolts or other fastenings as shown on the plans, and shall be drawn taut and fastened securely on both ends, as shown.

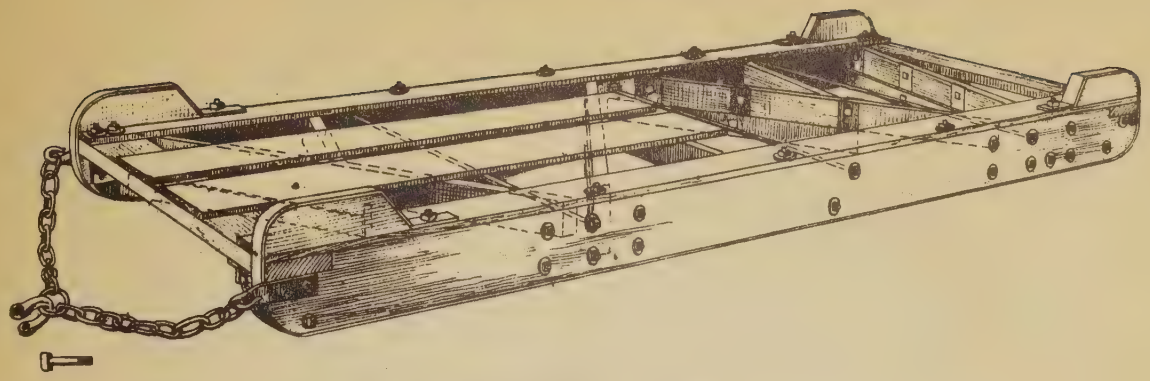
Holes for bolts shall be bored with a bit of the same diameter as the bolt. All bolts shall be given two coats of red-lead shop-paint as specified for structural steel.

After erection is completed, the posts and all metal fittings shall be painted with three coats of paint of the specified material and quality, which shall be brushed in thoroughly.

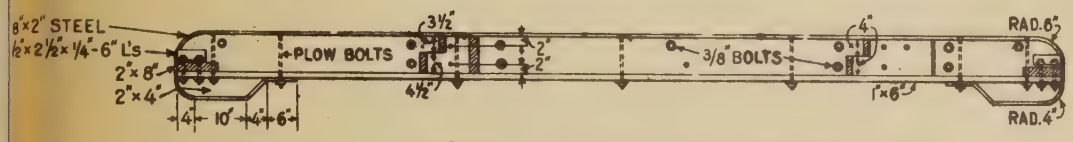
Method of Measurement. - The measurement shall be from outer post to outer post, and shall not include the distance from the end posts to the "dead man".

Basis of Payment. - This item shall be paid for at the contract unit price per lineal foot for "Wire-Cable Guardrail" complete in place, which price shall be full compensation for furnishing all wire cable, posts, and fittings; for all preparation and erection of same, for excavating and back filling and for all labor, equipment, tools, and incidentals necessary to complete the work.

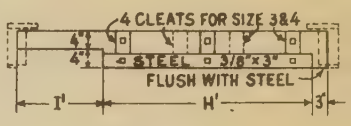
ROAD PLANER



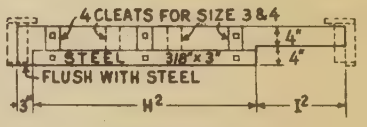
PERSPECTIVE VIEW



INSIDE FACE LEFT RUNNER



BLADE 1



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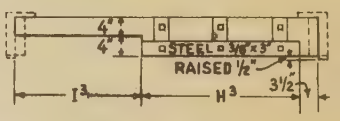
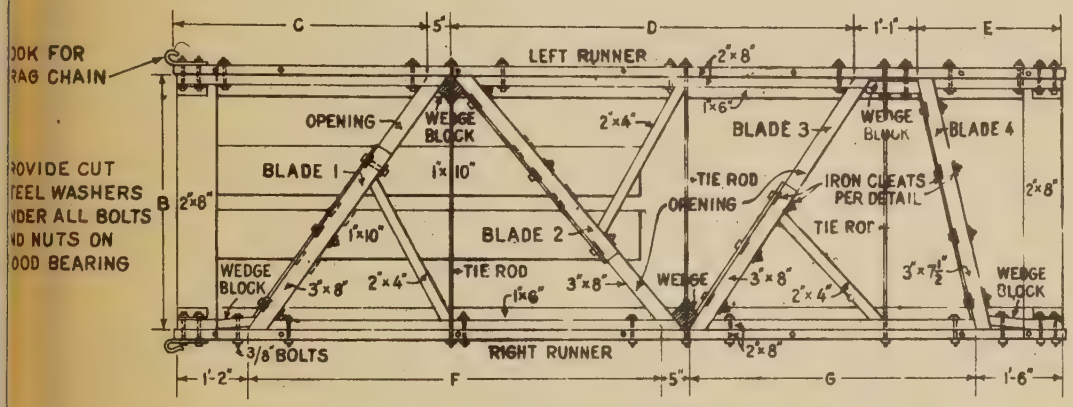
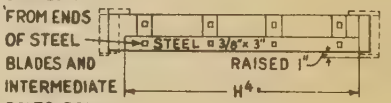


BLADE 3

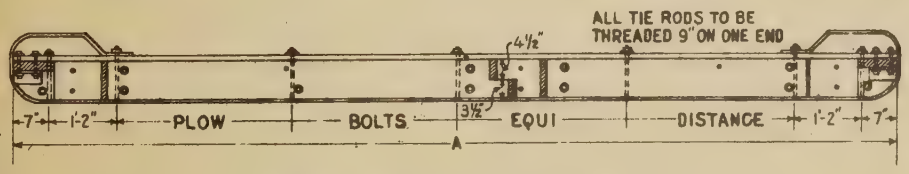


PLAN OF UNDERSIDE

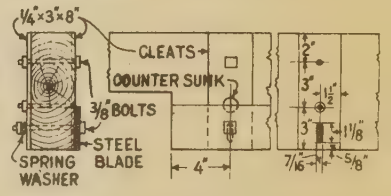


BLADE 4

UNNERS CONSTRUCTED
2 PIECES 2"×8",
PIKED AND
OLTED. INSIDE
ECE CUT FOR
LADES AS SHOWN.
LADES TO BE
DJUSTABLE VERT-
ALLY AND HELD TO
UNNERS BY BOLTED
EDGE BLOCKS.



INSIDE FACE RIGHT RUNNER



CLEATS AND WOOD BLADES ARE SLOTTED FOR ADJUSTING, LOWERING, REVERSING, AND REMOVING WORN STEEL BLADES. CLEATS ON CUTTING SIDE OF BLADE ARE REBATED FLUSH WITH FACE OF WOOD BLADE

DETAILS OF IRON CLEATS

MPORTANT NOTE :-
O DEVIATIONS FROM DESIGN
RE PERMITTED, TO ALLOW
EADY REPLACEMENT OF WORN
R BROKEN PARTS FROM STOCK

DETAIL PLANS

SIZE	LENGTH	WIDTH	RUNNERS					BLADES							TIE RODS
								STEEL				OPENING			
	A	B	C	D	E	F	G	H'	H²	H³	H⁴	I'	I²	I³	
1	15'-0"	4'-4"	4'-2"	6'-10"	2'-6"	7'-0"	4'-11"	3'-5"	3'-11"	3'-5"	4'-0"	1'-7¼"	1'-5½"	1'-5½"	½"×57½"
2	16'-7"	5'-0"	4'-7"	7'-10"	2'-8"	8'-0"	5'-8"	4'-0"	4'-6"	4'-0"	4'-8"	1'-9¾"	1'-9"	1'-8"	½"×65½"
3	18'-3"	5'-8	5'-1"	8'-10"	2'-10"	9'-0"	6'-2"	4'-7"	5'-1"	4'-7"	5'-4"	2'-0¾"	2'-0"	1'-11"	5/8"×73½"
4	19'-11"	6'-4"	5'-7"	9'-10"	3'-0"	10'-1"	6'-9"	5'-2"	5'-9"	5'-2"	6'-0"	2'-3¾"	2'-2¾"	2'-1½"	5/8"×81½"

PROJECT:- NO.

ROAD PLANER SIZE SPECIFIED

INDEX